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ASTRONOMICAL JOURNAL.

E D I T E D B Y

BENJ. APTHORP GOULD, JR.,

PH. DR., FELLOW OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES, OF THE AMERICAN
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NOMICAL SOCIETY OF LONDON, OF THE ACADEMIES OF
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VOL. V.

ALBANY, 1856, NOVEMBER 26.

NO. 1.

ON THE ORBIT OF THE THIRD COMET OF 1853.

BY JOHN N. STOCKWELL.

THE great length of time during which the Comet 1853, III. was visible rendered the determination of its orbit with great precision very desirable. But on account of the large heliocentric arc which it described during its visibility (amounting to nearly 268°), the determination of the unknown quantities P and Q was rendered very troublesome; and when determined, they gave an orbit which but imperfectly represented the middle place. Moreover, the combination of the three arcs and corresponding radius-vectors, separately, gave different conic sections for the orbit; although all differed almost imperceptibly from a parabola. From these considerations, it has appeared best to depend wholly on the parabolic theory in the determination of the orbit. This supposition can differ but slightly from the truth, and it accords equally well with the observations.

By the aid of approximate elements, the observations were reduced, and the following normal places (which are referred to the mean equinox of 1853.0, and Greenwich mean time) were taken out.

Date.	α	δ
1853, June 12.0	143° 13' 30.9"	+43° 19' 47.3"
June 18.0	144 23 2.6	+42 43 30.0
July 2.0	148 3 24.6	+41 11 40.6
July 29.0	159 3 37.5	+37 7 0.8
Aug. 29.0	173 42 49.7	+16 26 34.4
Oct. 22.0	143 49 4.4	-38 22 50.8
Nov. 25.0	130 57 27.8	-45 8 2.6
Dec. 12.0	120 24 24.2	-45 37 20.3
1853, Dec. 29.0	109 24 31.8	-43 9 31.9

From the normal places of June 18, August 29, and December 29, the following parabolic elements of this comet were obtained:—

T	1853, Sept. 1.70446
Ω	140° 31' 22.1"
π	310 56 58.8
$\pi - \Omega$	170 25 36.7
i	61 30 11.1
Log q	9.4871354

} Mean Eq. 1853.0

These elements represent the above normal places as follows:—

C. — O.			C. — O.		
Date.	$\delta \lambda$	$\delta \beta$	Date.	$\delta \lambda$	$\delta \beta$
June 12.0	-1.1	-8.2	Oct. 22.0	-28.3	-6.2
July 2.0	-4.6	+3.8	Nov. 25.0	- 6.5	+3.5
" 29.0	+8.1	+9.9	Dec. 12.0	- 0.1	+1.8
Aug. 29.0	0.0	-4.1			

This comparison is in longitude and latitude.

The expressions for the heliocentric equatorial co-ordinates are,

$$\begin{aligned} x &= [n9.9187332] r \sin (v + 238^\circ 58' 22.7") \\ y &= [9.9550622] r \sin (v + 310^\circ 7' 32.8") \\ z &= [9.8491068] r \sin (v + 191^\circ 25' 7.6") \end{aligned}$$

v is the true anomaly of comet.

With these data an ephemeris was computed for the period of the comet's visibility. The comparison of the ephemeris with the observations may be seen in the table below. The observations are referred to the mean equinox of 1853.0.

Greenwich Mean Time.	C. — O.		C. — O.		Place of Observation.
	$\Delta \alpha$	$\Delta \delta$	$\Delta \alpha$	$\Delta \delta$	
1853, June 10.50195					Göttingen.
11.43542	- 9.4	+18.1			"
13.50358	+ 0.1	-50.8			Hamburg.
17.37375	-25.0	+13.7			Vienna.
	-11.3	- 3.1			

Greenwich Mean Time.	α	δ	C. — O.		Place of Observation.
			$\Delta \alpha$	$\Delta \delta$	
1853, June 17.44939 ^d	141 15 51.9	+12 46 48.9	+ 6.7	+ 4.3	Berlin.
18.40766	144 28 16.1	42 41 0.1	+ 2.1	— 1.2	"
19.12715	144 41 47.3	42 34 39.8	+ 0.2	— 0.6	"
23.13203	145 39 12.1	42 9 16.6	—14.1	+ 1.7	Hamburg.
25.42957	146 9 26.8	41 56 11.3	+28 0	+ 7.3	"
28.43357	146 59 45.6	41 36 18.4	—11.5	+ 1.2	"
29.41351	147 16 39.0	41 29 45.9	— 5.5	— 6.1	"
30.12394	147 34 37.4	41 22 38.7	— 8.0	+ 4.4	"
July 1.42036	147 52 45.4	41 15 44.4	— 8.2	+ 3.9	"
2.42460	148 11 18.1	41 8 44.0	— 1.1	+ 0.3	"
3.41875	148 30 10.5	41 1 35.4	— 0.1	+ 3.9	"
8.43361	150 11 42.2	40 24 24.9	+ 3.3	+ 7.3	"
11.42047	151 17 21.0	40 1 2.8	— 3.2	+ 1.6	"
15.40555	152 50 41.6	39 27 43.9	+ 2.5	+ 4.1	"
19.39314	154 31 17.5	38 51 38.1	— 2.4	+ 2.8	"
20.40232	154 57 56.2	38 42 3.0	— 6.2	— 3.5	"
23.38953	156 19 0.9	38 11 41.0	+16.8	+ 5.4	"
27.40629	158 15 18.0	37 26 34.5	+14.4	+ 8.9	"
28.37567	158 44 38.8	37 14 51.5	+ 7.5	+ 3.9	"
28.57462	158 50 33.2	37 12 27.2	+16.5	— 0.2	Washington.
30.57396	159 52 33.1	36 46 33.0	+13.9	+ 3.2	"
31.38115	160 18 5.3	36 35 35.8	+16.2	— 1.0	Hamburg.
Aug. 2.38191	161 22 45.0	36 6 25.4	+21.7	+ 13.7	"
4.40040	162 29 59.9	35 34 57.1	+22.0	— 13.5	"
5.37461	163 3 11.6	35 18 20.3	+19.9	— 4.5	"
6.57001	163 44 14.1	34 56 57.0	+31.9	— 2.4	Washington.
7.34726	164 11 41.8	34 42 11.8	+12.5	+ 6.7	Hamburg.
7.55849	164 19 27.0	34 38 9.0	— 7.7	+ 6.2	Washington.
8.37046	164 47 46.0	34 22 4.2	+12.4	+ 0.4	Hamburg.
8.56246	164 54 37.9	34 18 7.3	+ 9.2	+ 2.1	Washington.
9.36625	165 23 23.3	34 1 15.8	+ 1.5	— 3.6	Hamburg.
9.54111	165 29 35.0	33 57 19.7	+11.6	+ 0.8	Washington.
10.53976	166 5 19.5	33 35 0.5	+14.1	— 2.4	"
10.54595	166 5 24.7	33 34 47.9	+18.0	+ 4.3	"
11.34648	166 34 31.4	33 15 54.4	+16.8	+ 1.1	Hamburg.
11.53920	166 41 28.9	33 11 10.8	+18.9	+ 2.6	Washington.
11.54181	166 41 29.6	33 11 5.9	+23.9	+ 2.9	"
12.34666	167 10 48.7	32 50 46.4	+17.0	— 1.3	Hamburg.
12.55495	167 18 39.4	32 45 14.6	+ 0.8	+ 3.7	Washington.
13.53139	167 54 8.9	32 18 53.0	+ 5.6	— 11.0	"
14.34304	168 23 12.7	31 55 24.7	+33.5	— 17.1	Hamburg.
14.53875	168 30 41.5	31 48 13.5	+11.3	+ 60.0	Washington.
17.35862	170 11 15.1	30 13 30.8	+53.3	+ 31.4	Hamburg.
18.31727	170 45 28.5	29 34 26.9	+31.8	+ 2.4	"
19.56022	171 26 14.6	28 41 33.6	+15.4	+ 3.5	Washington.
20.52304	171 56 47.3	27 55 18.4	+12.8	— 16.6	"
21.32911	172 20 35.0	27 12 52.5	+23.4	+ 2.1	Hamburg.
21.52836	172 26 31.6	27 1 54.3	+ 9.4	+ 1.4	Washington.
22.52273	172 53 14.5	26 3 38.8	+15.8	+ 3.2	"
23.32937	173 12 28.2	25 14 53.4	+26.1	+ 23.4	Hamburg.
23.51469	173 16 44.9	25 1 52.5	+11.4	—153.7	Washington.
25.33235	173 48 24.8	22 41 54.5	+ 1.8	+ 7.5	Hamburg.
26.31917	173 57 39.2	21 15 20.6	— 8.1	— 8.1	"
26.51423	173 58 32.3	20 57 3.1	— 1.8	— 9.0	Washington.
26.51919	173 58 28.5	20 56 35.7	+ 3.5	— 10.6	"
28.30373	173 52 56.3	17 49 31.8	+ 3.8	— 1.4	Hamburg.
28.51706	173 50 23.8	17 24 50.5	— 0.3	— 8.5	Washington.
29.51236	173 32 10.1	15 21 52.2	— 6.3	— 11.2	"
30.89960	172 47 57.5	12 11 15.7	+29.5	— 51.9	Olmütz.
30.94831	172 45 38.7	12 4 24.3	+52.5	— 68.0	"
Sept. 1.21568	171 47 4.8	+ 8 49 56.7	— 4.8	— 22.3	"

Greenwich Mean Time.		α		δ	C. — O.		Place of Observation.
					$\Delta \alpha$	$\Delta \delta$	
1853, Sept.	^d 1.85286	171° 9' 56.8"		+ 7° 6' 28.5"	+ 35.7	— 27.5	Olmütz.
	1.90650	171 6 56.3		6 58 1.4	+ 20.8	+ 10.0	"
	1.93949	171 4 49.7		6 52 52.9	+ 26.5	— 5.5	"
	1.95795	171 4 0.3		6 49 59.3	+ 7.9	— 13.5	"
	2.83156	170 8 37.3		4 25 16.7	— 110.1	— 59.9	"
	2.90299	170 1 35.2		4 13 13.0	+ 26.8	— 24.7	"
	2.93077	169 59 41.4		4 8 38.8	+ 24.2	— 10.3	"
	2.97666	169 56 57.4		4 0 56.2	— 4.9	— 30.0	"
	3.93884	168 46 12.6		1 18 55.0	— 11.3	— 27.4	"
	3.99058	168 42 11.4		1 10 8.8	— 8.5	— 24.2	"
	4.08053	168 35 52.0		0 55 26.9	— 45.2	— 48.1	"
	4.11471	168 32 56.2		0 49 17.4	— 28.3	— 22.2	"
	4.16125	168 30 3.3		+ 0 41 49.8	— 72.2	— 43.2	"
	12.65610			— 17 59 27.9		+ 110.7	Cape of Good Hope.
	12.66838	157 43 55.3			+ 45.0		" "
	13.63816			19 29 8.7		+ 468.4?	" "
	16.66797			22 53 14.6		— 3.8	" "
	16.66887	154 18 18.4			— 22.4		" "
	16.90315	154 8 23.0		23 6 22.5	+ 26.7	— 55.2	Santiago.
	17.65437			23 49 55.4		— 7.0	Cape of Good Hope.
	17.65923	153 37 24.6			— 23.4		" "
	17.89506	153 28 10.4		24 2 50.8	— 21.8	+ 17.3	Santiago.
	19.64970	152 25 7.8			— 38.6		Cape of Good Hope.
	19.65227			25 30 55.3		— 5.2	" "
	20.63469	151 53 40.6			— 63.7		" "
	20.66043			26 16 7.0		— 2.9	" "
	21.63857	151 24 11.3			— 86.2		" "
	21.64083			26 56 46.9		— 2.4	" "
	22.63248	150 57 13.2			— 30.6		" "
	22.64101			27 35 25.6		— 9.4	" "
	23.63123	150 32 11.9			— 30.5		" "
	23.64788			28 11 57.4		— 4.6	" "
	23.87122	150 26 22.8		28 19 39.9	— 23.6	— 5.3	Santiago.
	25.61414			29 16 52.5		— 4.7	Cape of Good Hope.
	25.63021	149 47 29.7			— 28.1		" "
	26.64765			29 48 17.8		— 4.8	" "
	26.65722	149 26 56.6			— 36.1		" "
	27.63380			30 16 45.3		— 2.0	" "
	27.63566	149 8 35.9			— 38.1		" "
	27.87558	149 4 24.1		30 23 29.4	— 40.2	— 2.4	Santiago.
	28.62257			30 43 57.0		— 0.9	Cape of Good Hope.
	28.63501	148 50 58.4			— 30.3		" "
	28.88316	148 46 43.3		30 50 54.4	— 28.9	— 0.4	Santiago.
	29.62134			31 10 11.9		— 1.1	Cape of Good Hope.
	29.62221	148 34 34.7			— 31.6		" "
	30.63012	148 18 44.7			— 38.6		" "
	30.63149			31 35 39.1		— 3.3	" "
	30.86376	148 15 13.9		31 41 26.7	— 36.8	+ 0.1	Santiago.
Oct.	1.63271			31 59 57.6		— 1.4	Cape of Good Hope.
	1.63578	148 3 47.5			— 34.1		" "
	4.62888			33 7 53.7		+ 0.8	" "
	4.62906	147 22 37.1			— 31.3		" "
	5.81401	147 7 23.0		33 32 58.2	— 39.9	— 30.4	Santiago.
	5.85075	147 7 3.0		33 34 4.1	— 45.0	— 5.7	"
	7.59985	146 45 24.7			— 30.0		Cape of Good Hope.
	7.61148			34 9 47.2		— 0.9	" "
	7.80602	146 42 52.5		34 13 36.2	— 27.2	— 2.3	Santiago.
	8.62136			34 29 49.2		+ 3.2	Cape of Good Hope.
	8.62147	146 33 8.7			— 31.9		" "
	11.61201	145 57 53.1			— 32.0		" "
	11.61236			— 35 26 22.7		+ 0.3	" "

Greenwich Mean Time.	α	δ	C. - O.		Place of Observation.
			$\Delta \alpha$	$\Delta \delta$	
1853, Oct. 13.60283	145° 34' 27.6"		-28.4		Cape of Good Hope.
13.60469		-36° 2' 22.9"		-9.1	" "
14.61730		36 20 13.3		-9.4	" "
14.61868	145 22 30.7		-34.8		" "
19.54489		37 43 22.2		+ 1.3	" "
19.55417	144 21 36.6		-31.2		" "
21.57487	143 54 50.3		-24.0		" "
21 57541		38 16 5.3		+ 1.5	" "
22.60441		38 32 22.1		+ 2.0	" "
22.60458	143 40 46.3		-23.8		" "
23.59902		38 47 54.3		+ 1.9	" "
23.60526	143 26 46.9		-26.3		" "
26.59776		39 33 36.6		- 0.1	" "
26.59791	142 42 22.1		-21.7		" "
27.61235		39 48 44.0		+ 0.8	" "
27.61409	142 26 29.3		-25.4		" "
28.59628		40 3 16.4		+ 5.1	" "
28.59651	142 10 27.7		-17.6		" "
29.59193		40 17 45.0		+ 6.6	" "
29.59692	141 53 53.4		-21.4		" "
31.54467	141 20 6.1		-27.4		" "
31.55039		40 45 37.0		+ 5.7	" "
Nov. 1.58499	141 0 50.0		- 6.5		" "
1.59484		41 0 7.7		+ 3.0	" "
2.57007	140 42 33.4		-18.6		" "
2.57032		41 13 33.3		+ 4.7	" "
3.54199	140 23 53.8		-25.6		" "
3.54265		41 26 41.4		+ 4.0	" "
4.53277	140 4 5.4		-18.6		" "
4.53285		41 39 54.5		-13.4	" "
5.53311		41 53 2.9		+ 9.3	" "
5.54165	139 43 19.9		-13.0		" "
6.53337	139 22 31.5		-19.9		" "
6.53376		42 5 49.0		+ 4.0	" "
7.50557	139 1 26.4		-19.4		" "
7.50699		42 18 7.6		+ 6.7	" "
8.47854	138 39 39.3		-13.9		" "
8.47994		42 30 7.5		+ 2.2	" "
10.49773	137 52 47.0		-17.7		" "
10.49819		42 54 16.6		+ 7.1	" "
11.48250		43 5 36.2		+ 0.4	" "
11.48260	137 28 51.2		-12.7		" "
12.50074	137 3 29.5		- 9.6		" "
12.50087		43 17 4.8		+ 6.1	" "
13.50914	136 37 47.5		-12.0		" "
13.50974		43 28 6.3		+ 5.3	" "
15.52489		43 49 13.9		+ 1.1	" "
15.52589	135 44 22.5		-15.3		" "
16.44381		43 58 20.4		+ 3.6	" "
16.44440	135 18 58.1		- 3.5		" "
17.46752		44 8 11.4		+ 2.4	" "
17.46832	134 50 12.9		- 8.6		" "
18.47378	134 21 15.6		- 9.4		" "
18.47428		44 17 29.2		+ 3.2	" "
19.46861		44 26 18.1		+ 3.7	" "
19.46893	133 51 57.1		- 8.6		" "
20.50882		44 35 9.2		+ 4.3	" "
20.50957	133 20 35.6		- 6.2		" "
22.45005	132 20 20.2		- 7.7		" "
22.45035		44 50 26.7		+ 3.5	" "
24.45962		45 4 34.5		+ 8.0	" "

Greenwich Mean Time.	α	δ	C. — O.		Place of Observation.
			$\Delta \alpha$	$\Delta \delta$	
1853, Nov. 24.46802	131° 15' 7.0		— 5.7		Cape of Good Hope.
25.47419	130 41 41.8		— 5.9		" "
25.47431		—45° 11' 0.3		+4.0	" "
26.46286	130 8 10.3		+ 0.4		" "
26.46345		45 16 46.2		+1.9	" "
28.46471	128 58 52.5		— 6.5		" "
28.46483		45 27 5.3		+6.4	" "
29.46882	128 23 14.8	45 31 26.4	— 5.9	+5.4	" "
30.44964	127 47 55.3		— 3.8		" "
30.44972		45 35 10.4		+3.7	" "
Dec. 1.47067	127 10 40.1		— 4.8		" "
1.47538		45 38 32.8		+4.7	" "
2.45138	126 34 22.0		— 0.3		" "
2.45238		45 41 12.8		+5.2	" "
4.42578		45 44 56.8		+5.6	" "
4.42755	125 20 5.0		+ 0.7		" "
5.45720		45 45 56.6		+4.7	" "
5.47451	124 40 12.5		— 2.8		" "
6.45726		45 46 18.8		+3.5	" "
6.46764	124 1 59.8		— 3.6		" "
7.41440	123 25 5.1		+ 5.5		" "
7.41481		45 46 9.0		+5.3	" "
8.44838		45 45 18.4		+5.1	" "
8.44902	122 44 39.6		+ 7.1		" "
10.49872		45 41 38.1		+0.2	" "
10.49940	121 23 52.3		+ 5.5		" "
11.44610	120 46 26.1		— 0.5		" "
11.44649		45 39 4.5		+0.8	" "
12.40925	120 8 22.4		—11.4		" "
12.41124		45 35 54.5		+2.7	" "
17.39154		45 9 56.0		+1.3	" "
17.39282	116 49 27.4		— 3.2		" "
18.33947	116 11 50.6		— 1.7		" "
18.33948		45 3 9.8		—0.6	" "
19.34320		44 55 25.8		+0.5	" "
19.35352	115 31 43.1		— 2.2		" "
20.37077	114 51 42.5		— 5.7		" "
20.38020		44 46 42.8		—0.7	" "
22.37588	113 33 24.1		— 1.9		" "
22.37634		44 28 8.8		—2.5	" "
23.36264		44 18 2.0		—4.7	" "
23.36347	112 55 11.6		+ 1.1		" "
24.36413	112 16 52.5		— 0.1		" "
24.36452		44 7 15.2		—1.6	" "
25.40167	111 37 30.5		— 1.7		" "
25.40535		43 55 24.5		+1.6	" "
26.35246		43 44 2.6		+2.3	" "
26.35399	111 1 47.7		— 1.0		" "
28.36767		43 18 7.0		+0.9	" "
28.36827	109 47 24.2		+ 4.2		" "
29.37267		43 4 18.0		—3.5	" "
29.37271	109 11 8.8		— 2.8		" "
30.35280		42 50 33.2		—1.8	" "
30.36622	108 35 41.1		— 1.0		" "
31.33895	108 1 34.6		— 4.9		" "
1853, Dec. 31.34154		42 35 52.4		+0.3	" "
1854, Jan. 1.37141		42 20 10.3		—0.2	" "
1.37150	107 25 48.8		— 2.4		" "
2.38104	106 51 30.4		— 7.2		" "
2.38379		42 4 17.2		+3.0	" "
4.34513		—41 31 58.2		—3.7	" "

Greenwich Mean Time.	α	δ	C. — O.		Place of Observation.
			$\Delta \alpha$	$\Delta \delta$	
1854, Jan. ^d 4.34647	105° 46' 34.5"		— 4.7"		Cape of Good Hope.
7.48893	104 7 53.5		— 5.1		" "
7.49125		—40° 36' 53.7"		—0.5"	" "
8.34085		40 21 21.4		+0.4	" "
8.34151	103 42 17.9		— 7.0		" "
9.56272		—39 58 32.3		+0.5	" "
9.56401	103 6 30.8		—11.7		" "

It should be observed, however, that the Cape of Good Hope observations are not as they were given by Mr. MACLEAR in No. 88 of the *Astronomical Journal*, — the α and δ here being the mean places deduced from his observations.

Brecksville, Ohio, 1856, 7 October.

OBSERVATIONS AT WASHINGTON OF ALGOL-MINIMA.

By CHARLES A. SCHOTT,
ASSISTANT U. S. COAST-SURVEY.

THE sky was remarkably clear, but the bright moonlight made it somewhat difficult to see ρ *Persei* as well as β when near the minimum.

1855, Feb. 28.

Washington M. T.	Comparison.		Washington M. T.	Comparison.	
^h ^m 8 15	β 1 ρ	β 1 δ	^h ^m 9 3	β 0.5 ρ	δ 1 β
21	1	$\beta = \delta$	10	0.5	1
27	0.5	δ 1 β	16	0.5	1
33	0.5	1	22	0.5	1
39	0.5	1	28	0.5	1
45	0.5	1	34	0.8	δ 0.5 β
51	=	1	40	0.8	$\beta = \delta$
8 57	$\beta = \rho$	δ 1 β	9 46	β 1 ρ	$\beta = \delta$

Minimum by comparison with ρ : —

with δ : —

$$\left. \begin{array}{l} \text{8 } 62 \\ \text{60} \\ \text{56} \\ \text{8 } 54 \end{array} \right\} \text{8 } 58.0 \text{ (weight, 2)} \quad \left. \begin{array}{l} \text{8 } 62 \\ \text{59} \\ \text{8 } 60 \end{array} \right\} \text{8 } 60.3 \text{ (weight, 1)}$$

Final result, ^h ^m
8 58.8

1856, Nov. 11.

The sky was remarkably clear, the moonlight bright.

Time by Watch.	Relative Brightness.		Time by Watch.	Relative Brightness.	
^h ^m 12 48	$\delta = \beta$	$\beta \frac{3}{4} \rho$	^h ^m 13 42	$\delta \frac{3}{4} \beta$	$\beta = \rho$
54	$\frac{1}{4}$	$\frac{3}{4}$	48	$\frac{3}{4}$	=
13 0	=	$\frac{1}{2}$	54	$\frac{1}{2}$	$\frac{1}{4}$
6	$\frac{1}{4}$	$\frac{1}{2}$	14 0	$\frac{1}{4}$	$\frac{1}{2}$
12	$\frac{1}{2}$	$\frac{1}{4}$	6	$\frac{1}{4}$	$\frac{1}{2}$
18	$\frac{1}{2}$	$\frac{1}{4}$	12	=	$\frac{3}{4}$
24	$\frac{3}{4}$	=	18	=	$\frac{3}{4}$
30	$\frac{3}{4}$	=	14 24	$\delta = \beta$	$\beta \frac{3}{4} \rho$
13 36	$\delta \frac{3}{4} \beta$	$\beta = \rho$			

Resulting Time of Minimum.

By δ .		By φ .	
Relative Brightness.	Time.	Time.	Relative Brightness.
(From $\frac{3}{4}$)	13 36.0	13 36.0	(From =)
(" $\frac{1}{2}$)	34.5	34.5	(" $\frac{1}{4}$)
(" $\frac{1}{4}$)	31.5	33.0	(" $\frac{1}{2}$)
(" =)	13 30.0	13 34.5	(" $\frac{3}{4}$)
Means	13 33.0	13 34.5	

Therefore, Observed time, $13^{\text{h}} 33.75^{\text{m}}$
 Watch fast, 2.25
 Concluded minimum, $13^{\text{h}} 31.50^{\text{m}}$ Washington mean time.

LETTER FROM MISS MITCHELL TO THE EDITOR.

Nantucket, 1856, November 3.

I SEND you the times of the minima of *Algol* as observed by me. The later observations are undoubtedly the best, as I have been more careful of the condition of the chronometer, have made notes of the changes of light at shorter intervals, and have been able to improve in my methods of observing. I have taken care not to know the exact time at which the phenomenon was expected to occur, that I might not be biased in my judgement.

I have taken for minimum the instant of greatest faintness, and not the middle point of a long period of dimming.

The observations have been made mostly with a comet-seeker constructed by Mr. Fitz of New York, but I have at times used a telescope of larger power belonging to the Coast-Survey. I have compared the star with the neighboring stars of nearly equal size, first with the eye, and then with the glass, sometimes assisting my judgement by throwing the instrument out of focus and comparing the haloes around the stars, and sometimes by illuminating the field and observing which star first disappeared under the same degree of light; in each case making a note.

I have discontinued the observation as soon as I have been quite confident that the star was steadily brightening, but I

have at other times made notes of its relative brightness when apparently at its mean and at its maximum.

I have never seen a sudden and great change; that the diminution of light is irregular, I have not a doubt; that the color of the star changes, I am inclined to believe; and I have at times noticed an appearance of haziness around it when it was near its minimum, as if its light came to us through a medium varying in density, perhaps a revolving atmosphere.

MINIMA OF *ALGOL*.

		Nantucket Mean Time.			
		d	h	m	s
1853,	Dec.	25	6	38	30
1854,	March	1	7	25	0
"	"	21	7	40	0
"	Oct.	22	8	40	0
1855,	June	11	14	43	48
"	Sept.	5	14	52	27
"	"	8	11	48	30
"	"	11	8	38	48
"	Nov.	13	10	20	28
"	Dec.	6	8	51	46
1856,	Oct.	25	9	1	38

MARIA MITCHELL.

NEW WORKS.

1. *American Ephemeris and Nautical Almanac*.—THE volume for 1859 of this periodical is now nearly through the press, and will very soon be issued.—The late Superintendent, Commander C. H. DAVIS, having been ordered by the Navy Department to active service, the preparation of

the *Almanac* was assigned by the Secretary to the Bureau of Ordnance and Hydrography. And it is an occasion for congratulation to the astronomical public, that the superintendence has been confided by the Bureau to an astronomer of attainments and ability, already known by his scientific labors.

Professor JOSEPH WINLOCK, who has recently received a commission in the U. S. Navy, has been appointed to this office, and under his highly competent direction, and with the continued co-operation of Professor PEIRCE, we are warranted in anticipating a largely increased usefulness of the work, which has now reached its fifth number.

2. *Greenwich Catalogue for 1850*. — Appended to the volume of Greenwich Observations for 1854, just published, is a new Catalogue of the Mean Places of 1576 stars, formed from six years' observations, from 1848 to 1853, and reduced to the epoch 1850; — thus forming a third work, similar in all important respects to the two Greenwich Catalogues by the combination of which the Twelve-Year Catalogue was formed. An additional reference-column gives the corresponding number in the Twelve-Year Catalogue, for those stars which are common to both.

Cambridge, 1856, November 18.

This valuable and welcome contribution of the Astronomer Royal to stellar astronomy contains also a reprint of the day-numbers for star-corrections, $\log E$, $\log F$, $\log G$, $\log H$, and L , for every day from 1856, January 1, to 1860, December 31, the values from 1849, January 1, having been given in the Twelve-Year Catalogue. And it is intimated that, after 1860, the publication of these numbers will probably be undertaken as a part of the Nautical Almanac.

The Annual Report of the Astronomer Royal to the Board of Visitors, accompanying the volume of the Greenwich Observations, is the *twentieth* by its distinguished author.

Another Appendix to the same volume gives a detailed description of the new Reflex Zenith-Tube, copiously illustrated by drawings, and with minute explanations of the modes of observation, and of the determination of the corrections.

G.

CORRIGENDA.

Vol. IV. page 103, line 3, for Jan., read June.

“ “ 140, 143, 141, the symbols ③⑥ and ③⑦ are transposed.

“ “ 169, Opposition-Ephemeris of *Eunomia* is for mean midnight.

“ “ 171, column 1, line 12, for fourteen, read twelve.

“ “ 191, the observatories for *Circe* and *Leucothea* are transposed.

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NEW WORKS.

CORRIGENDA.

THE ASTRONOMICAL JOURNAL.

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VOL. V.

ALBANY, 1856, DECEMBER 10.

NO. 2.

LOGARITHMIC VALUES OF $b_s^{(i)}$ AND ITS DERIVATIVES, IN THE PERTURBATIVE FUNCTION.

By JOHN D. RUNKLE,

ASSISTANT IN THE OFFICE OF THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC.

IN 1850, Sept. 19, Commander C. H. DAVIS, the Superintendent of the American Nautical Almanac, communicated to the *Astronomical Journal* a paper by the late SEARS C. WALKER, "On the Computation of Coefficients in the Development of the Perturbative Function." This paper is published in the *Journal* of Oct. 15, 1850, and contains the notation and formulas which Mr. WALKER used in computing the LeVerrier Coefficients for the *Almanac*, at the request of the Superintendent. These coefficients were published in 1854, in an Appendix to the *Almanac* for 1857. The natural sequel to this labor, after Mr. WALKER's death, was committed to me by the Superintendent, during which I was led to a form of general tables from which the coefficients $b_s^{(i)}$ and its derivatives are taken with trifling labor. These tables, with the following supplementary part, were lately communicated to the Smithsonian Institution, and the Secretary has courteously allowed the use of the stereotype plates prepared for its publication in the ninth volume of *Contributions to Knowledge*.

The construction and use of the tables may be learned from their Introduction, as published in the *Smithsonian Contribu-*

tions. The quantities in the following pages were taken from the tables by me personally, and after they were stereotyped they were taken out independently by another, and all the corrections thus found were introduced into the plates.

The quarto half-volume, XXIV., for the session 1854-55, of the *Memoirs of the Royal Astronomical Society*, contains a paper by A. D. WACKERBARTH, "On the Computation of the Numerical Values of the Constants requisite for Calculating a Theory of the Planet Neptune." The author of this paper, in speaking of LEVERRIER's transformations of the fundamental series, says: "The method is admirable, but requires a table of the coefficients of each series. Such a table once made answers for all values of α , and any one of the quantities $b_s^{(i)}$, or $D_\alpha^n b_s^{(i)}$, may be found at once with but little trouble. But till such a table is made, the use of LEVERRIER's formulas is very laborious." This is an unqualified justification, if any were needed, of the Superintendent's request, and of Mr. WALKER's computation of the LeVerrier Coefficients with such unwearied care and scrupulous accuracy.

In determining the values of α , the arguments of the tables, the following values of the masses and mean motions, which are those adopted in the *American Ephemeris and Nautical Almanac*, have been used.

Mercury,	$m^I = \frac{1}{4865751}$	$n^I = 5381016''.218$
Venus,	$m^{II} = \frac{1}{390000}$	$n^{II} = 2106641.438$
The Earth,	$m^{III} = \frac{1}{354936}$	$n^{III} = 1295977.440$
Mars,	$m^{IV} = \frac{1}{2680637}$	$n^{IV} = 689051.030$
Jupiter,	$m^V = \frac{1}{1047.879}$	$n^V = 109256.719$
Saturn,	$m^{VI} = \frac{1}{3501.6}$	$n^{VI} = 43996.127$
Uranus,	$m^{VII} = \frac{1}{24905}$	$n^{VII} = 15124.5094$
Neptune,	$m^{VIII} = \frac{1}{18780}$	$n^{VIII} = 7872.77382$

We have, then, for the value of α , the ratio of the mean distances of any two planets, as Mercury and Venus, the formula

$$\alpha = \left(\frac{n^{\text{II}}}{n^{\text{I}}} \right)^{\frac{2}{3}} \left(1 + \frac{m^{\text{I}} - m^{\text{II}}}{3} \right);$$

which takes into account the correction, necessary in the perturbative theory, due to the masses.

But if each planet is considered with reference to the Earth, the values of the mean distances a^{I} , a^{II} , a^{III} , &c. may first be found, since $a^{\text{III}} = 1$, and then the values of α .

We find for

Mercury,	$a^{\text{I}} = 0.38709870$	$\log a^{\text{I}} = 9.58782172$
Venus,	$a^{\text{II}} = 0.72333227$	$\log a^{\text{II}} = 9.85933784$
The Earth,	$a^{\text{III}} = 1.00000000$	$\log a^{\text{III}} = 0.00000000$
Mars,	$a^{\text{IV}} = 1.52369140$	$\log a^{\text{IV}} = 0.18289702$
Jupiter,	$a^{\text{V}} = 5.20280136$	$\log a^{\text{V}} = 0.71623725$
Saturn,	$a^{\text{VI}} = 9.53885533$	$\log a^{\text{VI}} = 0.97949626$
Uranus,	$a^{\text{VII}} = 19.18357126$	$\log a^{\text{VII}} = 1.28292946$
Neptune,	$a^{\text{VIII}} = 30.03680569$	$\log a^{\text{VIII}} = 1.47765375$

Hence, for

Mercury and Venus,	$\alpha = 0.5351603$	$\log \alpha = 9.7281839$	$\log \beta^2 = 9.6035107$
Mercury and the Earth,	$\alpha = 0.3870987$	$\log \alpha = 9.5878217$	$\log \beta^2 = 9.2461455$
Mercury and Mars,	$\alpha = 0.2540532$	$\log \alpha = 9.4019217$	$\log \beta^2 = 8.8388256$
Mercury and Jupiter,	$\alpha = 0.0744020$	$\log \alpha = 8.8715845$	$\log \beta^2 = 7.7455797$
Mercury and Saturn,	$\alpha = 0.0405813$	$\log \alpha = 8.6083251$	$\log \beta^2 = 7.2173667$
Mercury and Uranus,	$\alpha = 0.0201787$	$\log \alpha = 8.3048923$	$\log \beta^2 = 6.6099614$
Mercury and Neptune,	$\alpha = 0.0128875$	$\log \alpha = 8.1101680$	$\log \beta^2 = 6.2204080$
Venus and The Earth,	$\alpha = 0.7233323$	$\log \alpha = 9.8593378$	$\log \beta^2 = 0.0403481$
Venus and Mars,	$\alpha = 0.4747236$	$\log \alpha = 9.6764408$	$\log \beta^2 = 9.4637832$
Venus and Jupiter,	$\alpha = 0.1390275$	$\log \alpha = 9.1431006$	$\log \beta^2 = 8.2946777$
Venus and Saturn,	$\alpha = 0.0758301$	$\log \alpha = 8.8798416$	$\log \beta^2 = 7.7621877$
Venus and Uranus,	$\alpha = 0.0377058$	$\log \alpha = 8.5764084$	$\log \beta^2 = 7.1534347$
Venus and Neptune,	$\alpha = 0.0240815$	$\log \alpha = 8.3816841$	$\log \beta^2 = 6.7636201$
The Earth and Mars,	$\alpha = 0.6563009$	$\log \alpha = 9.8171030$	$\log \beta^2 = 9.8788884$
The Earth and Jupiter,	$\alpha = 0.1922042$	$\log \alpha = 9.2837628$	$\log \beta^2 = 8.5838733$
The Earth and Saturn,	$\alpha = 0.1018344$	$\log \alpha = 9.0205037$	$\log \beta^2 = 8.0458069$
The Earth and Uranus,	$\alpha = 0.0521279$	$\log \alpha = 8.7170705$	$\log \beta^2 = 7.4353228$
The Earth and Neptune,	$\alpha = 0.0332925$	$\log \alpha = 8.5223463$	$\log \beta^2 = 7.0451741$
Mars and Jupiter,	$\alpha = 0.2928598$	$\log \alpha = 9.4666598$	$\log \beta^2 = 8.9722626$
Mars and Saturn,	$\alpha = 0.1597353$	$\log \alpha = 9.2034008$	$\log \beta^2 = 8.4180265$
Mars and Uranus,	$\alpha = 0.0794269$	$\log \alpha = 8.8999676$	$\log \beta^2 = 7.8026836$
Mars and Neptune,	$\alpha = 0.0507275$	$\log \alpha = 8.7052133$	$\log \beta^2 = 7.4116055$
Jupiter and Saturn,	$\alpha = 0.5454325$	$\log \alpha = 9.7367410$	$\log \beta^2 = 9.6268336$
Jupiter and Uranus,	$\alpha = 0.2712113$	$\log \alpha = 9.4333078$	$\log \beta^2 = 8.8997962$
Jupiter and Neptune,	$\alpha = 0.1732112$	$\log \alpha = 9.2385835$	$\log \beta^2 = 8.4903967$
Saturn and Uranus,	$\alpha = 0.4972408$	$\log \alpha = 9.6965668$	$\log \beta^2 = 9.5164820$
Saturn and Neptune,	$\alpha = 0.3175722$	$\log \alpha = 9.5018425$	$\log \beta^2 = 9.0498539$
Uranus and Neptune,	$\alpha = 0.6386689$	$\log \alpha = 9.8052757$	$\log \beta^2 = 9.8381518$

With these values of α and β^2 we enter the Tables and take out the required coefficients, which are found on the following pages.

MERCURY AND VENUS.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_x b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_x^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_x^4 b_{\frac{1}{2}}^{(i)}$
0	0.3368936	99.6206871	99.8972897	0.2388589	0.8016751
1	99.7822639	99.8922032	99.8418921	0.2669438	0.7985490
2	99.3919845	99.7578828	99.9878240	0.2639757	0.8170165
3	99.0444586	99.5682264	99.9860811	0.3492156	0.8295626
4	98.7168905	99.3555162	99.9084175	0.3914858	0.8842750
5	98.4009294	99.1300174	99.7873191	0.3775499	0.9354334
6	98.092563	98.896347	99.638412	0.3195425	0.9550919
7	97.789597	98.656996	99.470354	0.228810	
8	97.49060	98.413474	99.288216		
9	97.19490	98.166718			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_x b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	0.3531933	0.5947884	1.1362336	0.5632360	
1	0.2107051	0.6129232	1.1227699		
2	0.0186280	0.5514420	1.1137060	0.4107724	
3	99.8048651	0.4467261	1.0786698		
4	99.5788115	0.3073166	1.0125432		
5	99.3448135	0.1467052	0.9191260		
6	99.1052495	99.9693565			
7	98.8615637				

MERCURY AND THE EARTH.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_x b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_x^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_x^4 b_{\frac{1}{2}}^{(i)}$
0	0.3184766	99.2546919	99.3989310	99.1220427	99.7628838
1	99.6139899	99.6668702	99.2622822	99.5008233	99.7371661
2	99.0798287	99.4111232	99.5250938	99.4562433	99.7872022
3	99.5899659	99.0885481	99.4433846	99.6221510	99.7828049
4	98.1207040	98.7394382	99.2505507	99.6353560	
5	97.6633767	98.3760072	99.0025367		
6	97.213840	98.0035704	98.7215190		
7	96.76980	97.6249551			
8	96.32984				
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_x b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	0.0459805	99.9373245	0.2581646	99.8858911	
1	99.7853941	0.0068851	0.2138736		
2	99.4615006	99.8803230	0.2202039	99.5589618	
3	99.1118471	99.6682696	0.1450095		
4	98.7481282				
5	98.3755292				

MERCURY AND MARS.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_x b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_x^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_x^4 b_{\frac{1}{2}}^{(i)}$
0	0.3082438	98.8424025	98.9049136	98.5490181	98.7173894
1	99.4157453	99.4374778	98.6272822	98.7368905	98.6196100
2	98.6969416	99.0101961	99.0578698	98.5895868	98.7510792
3	98.0232940	98.5090174	98.8315886	98.9130185	98.6765937
4	97.3705928	97.9793098	98.4698194	98.8042736	
5	96.7300025	97.4344104	98.0460740		
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_x b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.7708572	99.2594445	99.4148023	99.2858964	
1	99.3413761	99.1415556	99.2872887		
2	98.8396191	99.1903507	99.3590295	98.6705902	
3	98.3096765	98.8193952	99.1976237		

MERCURY AND JUPITER.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3016325	97.7458802	97.7512851	96.3240081	96.3404635
1	98.8724882	98.8742957	96.9719581	96.9819147	95.8193051
2	97.6192343	97.9212700	97.9252836	96.3693077	96.3848826
3	96.4116879	96.8895133	97.1923042	97.1993128	95.8853153
4	95.225311	95.827914			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.1780369	97.5765287	97.5913778	98.0592196	
1	98.2248103	98.2337851	97.0263193		
2	97.1930041	97.4982170	97.5148215	96.4373878	
3	96.1313849	96.6112183	96.9189960		

MERCURY AND SATURN.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3012093	97.2174553	97.2190619	95.2650906	95.2700362
1	98.6085938	98.6091299	96.1786498	96.1816249	94.4943723
2	97.0920105	97.3933388	97.3945312	95.3107115	95.3153870
3	95.6211696	96.0984995	96.4000520	96.4021379	94.5610483
4	94.1715118	94.7737328			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	98.9109658	96.7814557	96.7859097	97.5221507	
1	97.6951141	97.6977926	95.9650513		
2	96.4002605	96.7025122	96.7075262	95.3779943	
3	95.0751879	95.5534111	95.8564516		

MERCURY AND URANUS.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3010745	96.6099831	96.6103814	94.0491867	94.0507129
1	98.3049585	98.3050908	95.2672278	95.2679644	92.9741565
2	96.4849193	96.7860233	96.7863180	94.0952106	94.0963708
3	94.7106341	95.1878071	95.4889658	95.4894822	93.0413363
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	98.6063203	95.8694720	95.8705767	96.9119197	
1	97.0872375	97.0879007	94.7487026		
2	95.4890174	95.7903568	95.7915942	94.1622404	

MERCURY AND NEPTUNE.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3010482	96.2204167	96.2205795	93.2702259	93.2707270
1	98.1101949	98.1102487	94.6828366	94.6831374	92.0003003
2	96.0954270	96.3961873	96.3966076	93.3159697	93.3164139
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	98.4113602	95.2849716	95.2854233	96.5218167	
1	96.6975921	96.6978632	93.9692959		
2	94.9046608	95.2058173	95.2063234	93.3829501	

VENUS AND THE EARTH.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^5 D_{\alpha}^5 b_{\frac{1}{2}}^{(i)}$
0	0.3777387	0.0751753	0.6062955	1.3304800	2.2339265	3.2571104
1	99.9742423	0.2158375	0.5955403	1.3366398	2.2349877	3.2581326
2	99.7222879	0.1752740	0.6510807	1.3429395	2.2404308	3.2609114
3	99.5096630	0.0996032	0.6782990	1.3697966	2.2484968	3.2659903
4	99.3155264	0.0078221	0.6768729	1.4000746	2.2645398	3.2732901
5	99.1322252	99.9065691	0.6533964	1.1221359	2.2869730	3.2844533
6	98.956047	99.7990095	0.6132848	1.4315468	2.3107716	3.3002061
7	98.784955	99.686930	0.5604115	1.4277420	2.3311298	3.3191820
8	98.617623	99.571455	0.4975245	1.4116516	2.3418582	3.3399585
9	98.453251	99.453263	0.4265991	1.3816568	2.3503817	3.3590269
10	98.291240	99.332957	0.3491038	1.3481201	2.3472192	3.3744826
11	98.131160	99.210872	0.2661455	1.3033678	2.3355127	3.3847833
12	97.972728	99.087305	0.1785773	1.2514069	2.3157316	3.3890323
13	97.809310	98.962477	0.0870730	1.1931751	2.2885061	3.3868287
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^5 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^6 D_{\alpha}^5 b_{\frac{1}{2}}^{(i)}$
0	0.8590131	1.5251362	2.4126655			
1	0.8073433	1.5253162	2.4098989			
2	0.7277921	1.5068774	2.4040576			
3	0.6341595	1.4719142	2.3923886			
4	0.5318658	1.4235885	2.3731955			
5	0.4236621	1.3645764	2.3459447			
6	0.3111523	1.2969468	2.3107387			
7	0.1953592	1.2222139	2.2682820			
8	0.0769784	1.1416746	2.2190160			
9	99.9565006	1.0561729	2.1636585	3.2949178	4.4657772	5.6871063
10	99.8312894	0.9664059	2.1028268	3.2569379	4.4133426	5.6737091
11	99.7106216	0.8731223	2.0370794	3.2139903	4.4169447	5.6577201
12	99.5857112	0.7766490	1.9669190	3.1663382	4.3865409	5.6388507
i	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha} b_{\frac{1}{2}}^{(i)}$				
0	1.6520288					
2	1.6085195					
10	1.0169577	2.2415088				
11	0.9206974	2.1682542				
12	0.8216328	2.0912966				

VENUS AND MARS.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3283132	99.4769896	99.6938783	99.9122567	0.3810500
1	99.7173584	99.8005488	99.6119197	99.9555499	0.3723979
2	99.2735238	99.6229528	99.7993513	99.9412687	0.3998361
3	98.8731656	99.3848599	99.7725747	0.0571017	0.4094658
4	98.4930603	99.1221164	99.6547601	0.0909596	0.4862174
5	98.1247182	98.8458657	99.4881571		
6	97.764075	98.561057	99.2913313		
7	97.408846	98.270329			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	0.2234242	0.3281515	0.7758332	0.2777165	
1	0.0390136	0.3616490	0.7538055		
2	99.7989772	0.2810541	0.7474236	0.0667512	
3	99.5354049	0.1372379	0.6997284		
4	99.2587233				
5	98.9736609				

VENUS AND JUPITER.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3031463	98.2957335	98.3115632	97.4310860	97.4866127
1	99.1462753	99.1526329	97.7991402	97.8334042	97.2076815
2	98.1647907	98.4693659	98.4834389	97.4752552	97.5280039
3	97.2288875	97.7084935	98.0157400	98.0401876	97.2715070
4	96.314102	96.9180814	97.3990491	97.7096849	
5	95.41152	96.112051			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.4631797	98.4100228	98.4604358	98.6396471	
1	98.7792220	98.8102149	98.1117438		
2	98.0181761	98.3339507	98.3897984	97.5462166	
3	97.2276932	97.7143505	98.0388280		

VENUS AND SATURN.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3016559	97.7624999	97.7681145	96.3573617	96.3744455
1	98.8807804	98.8826583	96.9969247	97.0072649	95.8610681
2	97.6357877	97.9278624	97.9420319	96.4026136	96.4188144
3	96.4365002	96.9143532	97.2172126	97.2244928	95.9270734
4	95.2583823	95.8610061	96.3392568	96.6431106	
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.1865049	97.6015931	97.6170106	98.0763161	
1	98.2415003	98.2508215	97.0598027		
2	97.2179397	97.5233150	97.5105529	96.4707681	
3	96.1645717	96.6115102	96.9525494		

VENUS AND URANUS.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log a D_x b_{\frac{1}{2}}^{(i)}$	$\log a^2 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log a^3 D_x^3 b_{\frac{1}{2}}^{(i)}$	$\log a^4 D_x^4 b_{\frac{1}{2}}^{(i)}$
0	0.3011817	97.1535110	97.1519003	95.1370825	95.1113551
1	98.57766100	98.5771026	96.08526950	96.0852612	94.3312873
2	97.0281355	97.3294231	97.3304520	95.1827220	95.1867614
3	95.5253753	96.0026771	96.3041581	96.3059585	94.4010004
4	91.0437995	94.6159986			
i	$\log a b_{\frac{1}{2}}^{(i)}$	$\log a^2 D_x b_{\frac{1}{2}}^{(i)}$	$\log a^3 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log a^2 b_{\frac{1}{2}}^{(i)}$	
0	98.8788285	96.6853988	96.6892160	97.1577049	
1	97.6310965	97.6334096	95.8369102		
2	96.3043381	96.6064484	96.6107545	95.2199591	

VENUS AND NEPTUNE.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log a D_x b_{\frac{1}{2}}^{(i)}$	$\log a^2 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log a^3 D_x^3 b_{\frac{1}{2}}^{(i)}$	$\log a^4 D_x^4 b_{\frac{1}{2}}^{(i)}$
0	0.3010933	96.7636511	96.7612173	91.3569146	91.3586608
1	98.3817785	98.3819670	95.4977600	95.4988080	93.3587986
2	96.6385344	96.9396695	96.9400890	94.4026211	91.4042719
3	91.9110421	95.4182373	95.7191509	95.7201858	93.4256500
i	$\log a b_{\frac{1}{2}}^{(i)}$	$\log a^2 D_x b_{\frac{1}{2}}^{(i)}$	$\log a^3 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log a^2 b_{\frac{1}{2}}^{(i)}$	
0	98.6832809	96.1000820	96.1016540	97.0659721	
1	97.2409619	97.2419058	95.0562346		
2	95.7195213	96.0209948	96.0227555	91.4696891	

THE EARTH AND MARS.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log a D_x b_{\frac{1}{2}}^{(i)}$	$\log a^2 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log a^3 D_x^3 b_{\frac{1}{2}}^{(i)}$	$\log a^4 D_x^4 b_{\frac{1}{2}}^{(i)}$
0	0.3600512	99.9063288	0.3318839	0.9141702	1.6847103
1	99.9055625	0.0892258	0.3104128	0.9251659	1.6851936
2	99.6080871	0.0215561	0.3924579	0.9311108	1.6940369
3	99.3514193	99.9108645	0.4165453	0.9736804	1.7048208
4	99.1138839	99.7812022	0.3958855	1.0125710	1.7307937
5	98.887518	99.6406607	0.3448559	1.0303987	1.7642993
6	98.668488	99.4930083	0.2725474	1.0219435	
7	98.454661	99.310324	0.1846741	0.9987475	
8	98.244731	99.183856			
9	98.037747	99.024519			
i	$\log a b_{\frac{1}{2}}^{(i)}$	$\log a^2 D_x b_{\frac{1}{2}}^{(i)}$	$\log a^3 D_x^2 b_{\frac{1}{2}}^{(i)}$	$\log a^2 b_{\frac{1}{2}}^{(i)}$	
0	0.6531967	1.1628096	1.9145598	1.2140322	
1	0.5750996	1.1657938	1.9096196		
2	0.4610026	1.1367583	1.9017179	1.1418640	
3	0.3297791	1.0816108	1.8836598		
4	0.1883851	1.0069848	1.8522916		
5	0.0402136	0.9176828	1.8071144		
6	99.8571919	0.8170486			

THE EARTH AND JUPITER.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3051071	98.5859021	98.6218017	98.0209251	98.1228757
1	99.2898787	99.3021396	98.2375153	98.3018635	97.9506911
2	98.4493848	98.7572747	98.7843211	98.0636724	98.1609219
3	97.6543081	98.1362460	98.4493285	98.4960014	98.0117776
4	96.880206	97.4860667	97.9706649	98.2903438	
5	96.118424	96.8204336			
6	95.364507	96.145214			
7	94.616139	95.463471			

i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.6214901	98.8565780	98.9497818	98.9687006	
1	99.0753228	99.1337764	98.7122899		
2	98.4539620	98.7832731	97.8856386	98.1384352	
3	97.7936485	98.2991609	98.6417451		
4	97.1379183				

(To be continued.)

NEW WORKS.

Resultate aus Beobachtungen der Nebelflecken und Sternhaufen.
von H. D'ARREST. *Erste Reihe*, pp. 82. Leipzig. 1856.

This admirable work forms a part of the Memoirs of the Saxon Society of Sciences, and consists of a series of micrometric determinations of the absolute places of about six hundred nebulas, from the Catalogues of HERSCHEL and MESSIER, accompanied by thorough notes.

In addition to the results of his own observations, Professor D'ARREST has reduced the determinations of former astronomers to the same epoch, 1850.0, making use when possible of more recent and better positions for the comparison-stars; also, the complete reductions of all W. HERSCHEL'S nebulas of the first and fourth classes.

There are contained among these observations carefully determined positions of more than a hundred nebulas, of which no other determinations existed than those of the HERSCHEL'S; and also the places of three or four new ones. And Professor D'ARREST expresses his conviction that the number of still unknown nebulas of the brighter sort in the northern hemisphere must be extremely small. Two of the new ones are described as extremely bright.

Accompanying the observations are tables of such nebulas as do not now agree with the descriptions of former observers, tables in which no care has been spared to afford thoroughly trustworthy descriptions of the present aspect of these objects for a 6-foot telescope with an aperture of 52 Paris lines. No changes have been established in the relative positions of the double nebulas, or so-called nebular satellites.

Discussions are also given of the precision of the positions as determined by LACAILLE, MESSIER, W. HERSCHEL, J. HERSCHEL, LAUGIER, and D'ARREST himself; warranting the conviction that the accuracy of the determinations is quite com-

surate with that of comet observations of now-a-days. Proper motions or parallaxes appear in no case strongly probable.

A curious circumstance mentioned by D'ARREST is that several of the planetary nebulas occur in the *Histoire Céleste*, and in Bessel's Zones; not having been distinguished from fixed stars in the meridian-instruments.

Whether as regards the strikingly judicious selection of the work to which the small resources of the Leipzig Observatory might be most effectively devoted,—the wise discrimination, skill, and refinement showing through the whole,—or the permanent importance of the results,—there can be but one opinion; that, in the words of ARGELANDER, "it is a maturely thorough work, commenced with as much consideration and sense of what was needed, as it is carried out with skill and perseverance;—a work whose real fruit can only be harvested by those who are to follow us."

In this connection it may be well to append the mean places for 1850.0 of seven nebulas, communicated by Dr. C. H. F. PETERS, now at the Dudley Observatory in Albany, as having been observed by him at Capodimonte, in Naples, and which do not appear in any of the books. Only one of these is in the northern hemisphere.

α	δ	
h m s	° ' "	
15 36 13	—37 18 47	
17 13	+43 15	
17 39 46	—37 0 18	Large, blurred, foll. γ Telesc.
18 0 0	—25 55 33	Very small.
18 21 35	—32 25	Faint.
18 49 24	—36 50 3	Large, rather bright.
22 21 14	—21 36 28	Very large, prec. ν Aquarii.

Cambridge, 1856, Dec. 6.

G.

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NO. 3.

LOGARITHMIC VALUES OF $b_{\frac{1}{2}}^{(i)}$ AND ITS DERIVATIVES, IN THE PERTURBATIVE FUNCTION.

By JOHN D. RUNKLE,

ASSISTANT IN THE OFFICE OF THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC.

(Concluded from page 16.)

THE EARTH AND SATURN.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3022290	98.0464055	98.0571258	96.9279665	96.9601872
1	99.0223022	99.0259018	97.4236915	97.4433442	96.5760501
2	97.9180673	98.2211011	98.2290828	96.9728170	97.0033601
3	96.8591899	97.3380151	97.6125563	97.6564655	96.6112072
4	97.822063	96.4252059	96.9041969	97.2109187	
5	94.796844	95.4967015			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.3323249	98.0307485	98.0598969	98.3718510	
1	98.5271291	98.5148681	97.6335748		
2	97.6439413	97.9533146	97.9857812	97.0420271	
3	96.7310949	97.2136156	97.5280162		

THE EARTH AND URANUS.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3013256	97.4354695	97.4381242	95.7016881	95.7098238
1	98.7175135	98.7183990	96.5058565	96.5107585	95.0404733
2	97.3096947	97.6112174	97.6131856	95.7472204	95.7549146
3	95.9476085	96.4250747	96.7269674	96.7304084	95.1069740
4	94.6067012	95.2090280	95.6866818		
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.0207590	97.1091469	97.1164784	97.7425453	
1	97.9134779	97.9178933	96.4022975		
2	96.7273112	97.0304071	97.0386052	95.8147221	
3	95.5112547	95.9897052	96.2940507		

THE EARTH AND NEPTUNE.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3011507	97.0452335	97.0463171	94.9203609	94.9236944
1	98.5225269	98.5228872	95.9202246	95.9222280	94.0632816
2	96.9199546	97.2211851	97.2219871	94.9660264	94.9691775
3	95.3631295	95.8403912	96.1417725	96.1431767	94.1300459
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	98.8244597	96.5227863	96.5257875	97.3487309	
1	97.5227166	97.5245204	95.6199996		
2	96.1419128	96.4437851	96.4471449	95.0331992	
3	94.7311760	95.2088388	95.5112218		

MARS AND JUPITER.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3107113	98.9770487	99.0599399	98.8300984	99.0453381
1	99.4811814	99.5103889	98.8332179	98.9762844	98.9776184
2	98.8245306	99.1420587	99.2058544	98.8690316	99.0762273
3	98.2128292	98.7015819	99.0317499	99.1398730	99.0315969
4	97.6219911	98.2330619	98.7283933	99.0746535	
5	97.043213	97.7495567	98.3646694		
6	96.472329	97.2567116	97.9657798		
7	95.90695	96.7574834			
8	95.34575				
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.8548398	99.4756985	99.6755213	99.4671301	
1	99.4835937	99.6149205	99.5814924		
2	99.0423516	99.4097419	99.6250671	98.9550827	
3	98.5735187	99.0944484	99.4974752		
4	98.0898551				

MARS AND SATURN.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3038316	98.4194228	98.4442570	97.6817908	97.7540338
1	99.2076032	99.2160220	97.9857638	98.0307110	97.5230775
2	98.2865336	98.5922635	98.6108769	97.7254579	97.7941901
3	97.4109882	97.8911051	98.2006829	98.2329418	97.5859297
4	96.5565380	97.1611435	97.6433727	97.9571530	
5	95.714274	96.415321			
6	94.879965	95.659857			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.5296467	98.5995041	98.6652606	98.7770123	
1	98.9049807	98.9456991	98.3962028		
2	98.2038928	98.5241111	98.5970262	97.7977385	
3	97.4735386	97.9632879	98.2952057		

MARS AND URANUS.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3017169	97.8030264	97.8091849	96.4387118	96.4574277
1	98.9009978	98.9030588	97.0578109	97.0691483	95.9629399
2	97.6761412	97.9783178	97.9828929	96.4839476	96.5016662
3	96.4969847	96.9749090	97.2779470	97.2859339	96.0288542
4	95.3389952	95.9416747	96.4200358		
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.2071792	97.6627331	97.6796282	98.1180826	
1	98.2829098	98.2924315	97.1414900		
2	97.2787446	97.5845753	97.6034263	96.5521871	
3	96.2454874	96.7257004	97.0344186		

MARS AND NEPTUNE.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3013100	97.4117444	97.4112587	95.6541612	95.6618697
1	98.7056629	98.7065011	96.4702434	96.4748870	94.9810173
2	97.2860140	97.5875105	97.5893741	95.6997056	95.7069953
3	95.9120994	96.3895471	96.6913938	96.6946528	95.0475415
4	94.5593641	95.1616763	95.6393018		
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.0087906	97.0734690	97.0801149	97.7185002	
1	97.8897057	97.8938878	96.3546840		
2	96.6917194	96.9947059	97.0024735	95.7671776	
3	95.4638396	95.9422196	96.2463897		

JUPITER AND SATURN.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^5 D_{\alpha}^5 b_{\frac{1}{2}}^{(i)}$
0	0.3385227	99.6147536	99.9323668	0.2943834	0.8737065	1.5571443
1	99.7929617	99.9080126	99.8807510	0.3204252	0.8712013	1.5610525
2	99.4112293	99.7803232	0.0203404	0.3188200	0.8884925	1.5658199
3	99.0721127	99.5982403	0.0219675	0.3995635	0.9011930	1.5798031
4	98.7528969	99.3934022	99.9503069	0.4424607	0.9527604	1.5958171
5	98.445260	99.1759112	99.8362007	0.4325812	1.0028484	1.6320201
6	98.145206	98.9503245	99.6947800	0.3803462	1.0245924	1.6773991
7	97.850517	98.7190975	99.5343998	0.2962791	1.0130524	1.7122581
8	97.559818	98.483710	99.3601200	0.1880990	0.9715115	1.7254699
9	97.272369	98.245141	99.1752269	0.0612446		
10	96.98714	98.00416				
11	96.70391	97.76098				
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	0.3762360	0.6405825	1.1986313	1.8182258	0.6137241	
1	0.2401571	0.6567683	1.1862536	1.8459979		
2	0.0555698	0.6014522	1.1770313	1.8554065	0.4698123	
3	99.8496384	0.4991413	1.1438034	1.8414177		
4	99.6315700	0.3661981	1.0814342	1.8164763		
5	99.4056399	0.2121088	0.9931214	1.7741894		
6	99.1741927	0.0426529	0.8834073	1.7135764		
7	98.9386574	99.8615625	0.7563142	1.6344562		
8	98.6999680	99.6713775	0.6150429			
9	98.4587713	99.4738784	0.4620858			

JUPITER AND URANUS.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3092856	98.9038817	98.9750571	98.6769679	98.8656377
1	99.4156908	99.4705769	98.7211775	98.8451251	98.7823853
2	98.7554468	99.0704995	99.1249909	98.7168378	98.8980896
3	98.1102711	98.5972679	98.9230322	99.0157985	98.8380776
4	97.486006	98.0957127	98.5882625	98.9276587	
5	96.873837	97.5790530	98.1921618		
6	96.269539	97.0529901	97.7605062		
7	95.670777	96.520507			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.8086496	99.3576918	99.5322513	99.3671643	
1	99.4060486	99.5195467	99.4207972		
2	98.9321593	99.2899439	99.4788381	98.7999575	
3	98.4303359	98.9447839	99.3335720		
4	97.9135106				
5	97.3874000				

JUPITER AND NEPTUNE.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3013311	98.4920408	98.5212216	97.8294469	97.9135311
1	99.2435350	99.2534573	98.0951862	98.1481025	97.7091037
2	98.3577319	98.6613058	98.6862239	97.8727521	97.9528337
3	97.5174107	97.9984222	98.3091854	98.3471076	97.7712573
4	96.698170	97.3032331	97.7863873	98.1024699	
5	95.891104	96.5925262			
6	95.091992	95.872200			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.5693244	98.7113098	98.7879789	98.8595382	
1	98.9791094	99.0268276	98.5465870		
2	98.3129556	98.6369224	98.7214024	97.9460003	
3	97.6176584	98.1096632	98.4469597		
4	96.9068966				

SATURN AND URANUS.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3313200	99.5310896	99.7692508	0.0342514	0.5374908
1	99.7419927	99.8345228	99.6981179	0.0711778	0.5313225
2	99.3188110	99.6739120	99.8691952	0.0618363	0.5549586
3	98.9388512	99.4547104	99.8528345	0.1653903	0.5661350
4	98.5790462	99.2113929	99.7509771	0.2034016	0.6339224
5	98.230944	98.9548198	99.6022336		
6	97.890500	98.6898232	99.4241231		
7	97.555194	98.418992			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	0.2707586	0.4273481	0.9090815	0.3820620	
1	0.1028521	0.4541657	0.8907357		
2	99.8815026	0.3825507	0.8829489	0.1946360	
3	99.6372755	0.2530913	0.8404206		
4	99.3802273				
5	99.1149516				

SATURN AND NEPTUNE.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3124955	99.0555102	99.1528574	98.9955021	99.2422368
1	99.5190405	99.5536677	98.9537897	99.1200212	99.1890516
2	98.8978754	99.2185249	99.2939236	99.0332935	99.2713572
3	98.3215112	98.8124824	99.1482174	99.2753084	99.2409713
4	97.765950	98.3787471	98.8776094	99.2325567	
5	97.222425	97.9301765	98.5478353		
6	96.686750	97.472343			
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	99.9060934	99.6037404	99.8337030	99.5787130	
1	99.5675621	99.7205960	99.7562985		
2	99.1606227	99.5399608	99.7865741	99.1230705	
3	98.7265189	99.2555761	99.6760942		
4	98.2777608				
5	97.8198198				

URANUS AND NEPTUNE.

i	$\log b_{\frac{1}{2}}^{(i)}$	$\log \alpha D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^3 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^4 D_{\alpha}^4 b_{\frac{1}{2}}^{(i)}$
0	0.3560705	99.8638782	0.2648420	0.8115144	1.5197002
1	99.8877784	0.0586025	0.2397216	0.8242115	1.5502635
2	99.5777458	99.9827065	0.3297006	0.8296527	1.5598299
3	99.3088556	99.8618339	0.3517696	0.8771771	1.5712163
4	99.0592408	99.7213150	0.3246251	0.9177603	1.6003951
5	98.8208746	99.5695925	0.2650304	0.9330233	1.6368631
6	98.589898	99.4105746	0.1830624	0.9219949	1.6663271
7	98.364156	99.2464174	0.0848955	0.8883071	1.6808770
8	98.142317	99.078414	99.9745172	0.8359697	1.6782061
9	97.923459	98.907462	99.8546237	0.7683861	
10	97.70712	98.731127	99.7271213	0.6882557	
11	97.49272	98.558858	99.5934081		
12	97.27994	98.381556	99.4544996		
i	$\log \alpha b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 D_{\alpha} b_{\frac{1}{2}}^{(i)}$	$\log \alpha^3 D_{\alpha}^2 b_{\frac{1}{2}}^{(i)}$	$\log \alpha^2 b_{\frac{1}{2}}^{(i)}$	
0	0.6048327	1.0748668	1.7937073	1.1101211	
1	0.5187735	1.0791600	1.7879788		
2	0.3946344	1.0467691	1.7796214	1.0287654	
3	0.2526312	0.9853565	1.7595863		
4	0.1001034	0.9027548	1.7242974		
5	99.9405998	0.8044232	1.6737988		
6	99.7761207	0.6940781	1.6095105		
7	99.6079077	0.5742955	1.5332226		
8	99.4367866	0.4469509	1.4465602		

ON THE PHYLLOTAXIS.

By CHAUNCEY WRIGHT,

ASSISTANT IN THE OFFICE OF THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC.

§ 1.

General Properties of the Phyllotactic Surds.

The fractions $\frac{1}{2}, \frac{1}{3}, \frac{2}{5}, \frac{3}{8}, \&c.$, each of which has a numerator equal to the sum of the two preceding numerators, and a denominator equal to the sum of the two preceding denominators, have been shown to be the successive approximations of the continued fraction

$$\frac{1}{2 + \frac{1}{1 + \frac{1}{1 + \frac{1}{1 + \&c.}}}}$$

The value of this fraction is obtained from the expression

$$\frac{1}{2 + x}$$

in which

$$x = \frac{1}{1 + x} = \frac{1}{1 + \frac{1}{1 + \frac{1}{1 + \&c.}}}$$

The successive approximations of x are

$$1, \frac{1}{2}, \frac{2}{3}, \frac{3}{5}, \frac{5}{8}, \&c.,$$

and its exact value is the root $\frac{1}{2}(\sqrt{5} - 1)$ of the equation

$$x^2 + x = 1$$

hence

$$\frac{1}{2 + x} = \frac{1}{2} (3 - \sqrt{5})$$

The sum of these two surds is unity, and the latter is equal to the square of the former; hence they divide unity in *extreme and mean ratio*.

The equation

$$x^2 + x = 1$$

becomes by transposition

$$x^2 = 1 - x$$

which, in the form of a proportion, is

$$1 : x = x : 1 - x$$

that is, x and $1 - x$ divide unity in *extreme and mean ratio*.

Again, by geometry, if the base of a right-angled triangle = 1, and its altitude = $\frac{1}{2}$, the hypotenuse is $\frac{1}{2}\sqrt{5}$. Subtracting the altitude from the hypotenuse, we have remaining $\frac{1}{2}(\sqrt{5} - 1)$, and this subtracted from the base leaves $\frac{1}{2}(3 - \sqrt{5})$.

This process is the method in geometry of dividing a line in *extreme and mean ratio*.

If two quantities are in extreme and mean ratio, their sum is to the greater as the greater is to the smaller, or as the smaller is to their difference; hence the surds

$$(1.) \quad \begin{array}{ll} 1^\circ & \frac{1}{2}(\sqrt{5} - 1) \\ 2^\circ & \frac{1}{2}(3 - \sqrt{5}) \\ 3^\circ & \frac{1}{2}(2\sqrt{5} - 4) \\ 4^\circ & \frac{1}{2}(7 - 3\sqrt{5}) \\ 5^\circ & \frac{1}{2}(5\sqrt{5} - 11), \&c., \end{array}$$

each equal to the difference of the two preceding, are in geometrical progression with the ratio of the extreme and mean proportion. The first term $\frac{1}{2}(\sqrt{5} - 1)$ is equal to the common ratio, which we will indicate by k ; hence these surds are the successive powers of the first; that is

$$1^\circ = k, \quad 2^\circ = k^2, \quad 3^\circ = k^3, \quad \text{and } n^\circ = k^n.$$

The reciprocal of each of these surds is obtained by changing the sign $-$ to $+$, since the difference of the squares of the two terms within the parenthesis of each surd is equal to 4; moreover each surd may be represented by a continued fraction of the form

$$\frac{1}{a \pm \frac{1}{a \pm \frac{1}{a \pm \&c.}}}$$

in which a is the rational term of the surd, and the signs are $+$ for the odd surds, and $-$ for the even surds; thus,

$$\begin{array}{lllll} 1^\circ = \frac{1}{1 + \frac{1}{1 + \frac{1}{1 + \frac{1}{1 + \&c.}}}} & 2^\circ = \frac{1}{3 - \frac{1}{1 + \frac{1}{1 + \frac{1}{1 + \&c.}}}} & 3^\circ = \frac{1}{4 + \frac{1}{3 - \frac{1}{1 + \frac{1}{1 + \&c.}}}} & 4^\circ = \frac{1}{7 - \frac{1}{4 + \frac{1}{3 - \frac{1}{1 + \frac{1}{1 + \&c.}}}}} & 5^\circ = \frac{1}{7 - \frac{1}{7 - \frac{1}{4 + \frac{1}{3 - \frac{1}{1 + \frac{1}{1 + \&c.}}}}} \end{array}$$

The odd surds $1^\circ, 3^\circ, 5^\circ, \&c.$, may also be expressed by continued fractions of the form

$$\frac{1}{(a + 1) - \frac{1}{1 + \frac{1}{a - \frac{1}{1 + \frac{1}{a - \&c.}}}}}$$

cussed; that is, the intervals 1°, 2°, 3°. &c. of this arrangement are in geometrical progression with the ratio of the extreme and mean proportion for

$$\begin{aligned} 1^\circ &= \frac{1}{m+k} \\ 2^\circ &= 1 - \frac{m}{m+k} = \frac{k}{m+k} \\ 3^\circ &= \frac{1}{m+k} - \frac{k}{m+k} = \frac{k^2}{m+k} \\ 4^\circ &= \frac{k-k^2}{m+k} = \frac{k^3}{m+k} \end{aligned}$$

and, in general,

$$n^\circ = \frac{k^{n-1}}{m+k}$$

2. If the ratio of the mean motions of two planets be indicated by r , and if x represent the fraction of the circumference between two successive heliocentric conjunctions, then

$$r = \frac{x}{1+x}$$

hence

$$x = \frac{r}{1-r}$$

If $r = k^2$, then

$$x = \frac{k^2}{1-k^2} = \frac{k^2}{k} = k$$

and if r be any one of the approximations of k^2 , $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, &c., then x is equal to the corresponding approximation of k ; 1 , $\frac{1}{2}$, $\frac{2}{3}$, &c. Thus, if $r = \frac{2}{5}$, $x = \frac{2}{5} \div \frac{3}{5} = \frac{2}{3}$.

Since, as Professor PEIRCE has shown, the mean motions of the planets form a progression in which the ratios are nearly expressed by a series of phyllotactic fractions, it follows that the intervals between the successive conjunctions of neighboring planets are also expressed by these fractions, and that their points of conjunction are thus distributed around the sun as leaves are around their axes, in the several systems. If the ratio of the mean motions of two planets were exactly k^2 , their points of conjunction would be distributed in the most rapid and thorough manner.

The idea of *thorough distribution* (in the leaves of plants with reference to the formation of wood, and in the conjunctions of planets with reference to their mutual perturbations) seems to be a central thought or typical principle of these natural arrangements. Variations from the typical arrangement produce in plants specific forms of symmetry, while in the planets they fulfil conditions as yet imperfectly understood.

The progression of the mean motions ought not to be geometrical, lest through the common ratio there occur constant repetitions of the same configurations in the whole system of planets, which would cause their action through one another to be always of the same character.

The ratios of this progression, therefore, while each approaches the typical ratio k^2 , ought to differ as much as possible among themselves, and most for the larger planets; as in fact they do.

§ 3.

The Phyllotactic Function.

Required the form of the function which by the substitution for the variable of the common series of numbers

$$1, 2, 3, 4, 5, 6, \&c.$$

gives the phyllotactic series of numbers

$$1, 1, 2, 3, 5, 8, \&c.$$

Each of the phyllotactic numbers is equal to the sum of the two preceding; hence the required function is subject to the condition

$$\Delta f(x + \frac{1}{2}) = f(x - 1).$$

If the exponentials

$$a^x, a^{x+1}, a^{x+2}, a^{x+3}, \&c.$$

be arranged with their differences in the following form,

$f(x)$	$\Delta f(x)$
a^x	$a^{x-1}(a^2 - a)$
a^{x+1}	$a^x(a^2 - a)$
a^{x+2}	$a^{x+1}(a^2 - a)$
a^{x+3}	$a^{x+2}(a^2 - a)$
$\&c.,$	

we find that they fulfil the given condition, provided

$$a^2 - a = 1$$

The roots of this equation are

$$\frac{1}{2}(1 + \sqrt{5}), \text{ and } \frac{1}{2}(1 - \sqrt{5})$$

equal respectively to k^{-1} and $-k$; hence the general form of the function, fulfilling the given condition, is

$$A k^{-x} + B (-k)^x.$$

This function, subjected to the farther conditions

$$f(0) = 0, \text{ and } f(1) = 1,$$

(which determine A and B), becomes

$$\frac{k^{-x} - (-k)^x}{\sqrt{5}}$$

hence the general expression of the phyllotactic fractions (2) is

$$k + \frac{(-k)^x}{k^{-x} - (-k)^x} \sqrt{5}, \text{ or in another form } \frac{k^{-(x-1)} - (-k)^{x-1}}{k^{-x} - (-k)^x}$$

which, by the substitution for x of the numbers

$$1, 2, 3, 4, \&c.$$

gives the values

$$0, 1, \frac{1}{2}, \frac{2}{3}, \&c.$$

If the function $A k^{-x} + B (-k)^x$ be subjected to the conditions

$$f(0) = 2, \text{ and } f(1) = 1,$$

it becomes

$$k^{-x} + (-k)^x$$

which, by the substitution for x of the numbers

$$1, 2, 3, 4, \&c.$$

gives the numbers

$$1, 3, 4, 7, \&c.$$

the rational terms of the surds (1).

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LOGARITHMIC VALUES OF $b^{(i)}$ AND ITS DERIVATIVES, IN THE PERTURBATIVE FUNCTION, BY JOHN D. RUNKLE, ESQ.
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NO. 4.

DETERMINATION OF THE ORBIT OF THALIA.

By ERNEST SCHUBERT.

[Report to Professor WINLOCK, Superintendent American Ephemeris.]

THERE were not a great many observations of *Thalia* made between its discovery in 1852 and the year 1855, and in the latter year there were but two observations, made in Berlin. Therefore the normal place derived from these two observations cannot be very exact, and since, in the whole, only four normals could be formed, I propose to obtain a fifth nor-

mal place, so soon as the observations of the year 1856 are published; and then to solve again the equations of condition.

The normals, referred to the mean equinox of 1854, Jan. 0, were obtained as follows, — the given times having been corrected for aberration.

Berlin Mean Time.		Observed		C. — O.		Place of Observation.
	^d	⊙ α	⊙ δ	Δ α	Δ δ	
1852, Dec.	15.36319	48° 0' 56".7	+16° 49' 53".6	—23.9	— 6.1	London, mean of 2 obs.
	16.40091	47 50 37.9	16 53 30.2	—26.9	8.2	Liverpool, mean of 2 obs.
	18.41442	47 31 46.6	17 0 48.2	—14.2	13.6	Hamburg.
	20.47940	47 14 38.4	17 8 31.9	— 6.7	10.7	Liverpool, mean of 5 obs.
	20.57935	47 13 52.7	17 8 52.4	— 7.7	8.2	Oxford.
	21.40056	47 7 36.4	17 12 5.7	(+ 1.0)	9.3	Berlin.
	21.43572	47 7 28.0	17 12 18.8	— 5.8	14.0	Bonn.
	22.36581	47 1 2.1	17 15 55.6	— 9.2	8.5	Berlin.
	23.28938	46 55 1.0	17 19 40.4	— 9.0	7.9	"
	24.30258	46 48 51.0	17 23 52.3	— 2.3	5.9	"
	27.34924	46 33 45.6	17 37 12.8	+ 8.9	14.5	Liverpool, mean of 5 obs.
	27.47769	46 33 18.5	17 37 48.2	+ 5.2	15.2	Oxford, mean of 2 obs.
	28.56485	46 29 15.9	17 42 43.5	+ 4.6	13.9	" "
	29.41619	46 26 30.8	17 46 42.5	+ 6.2	17.4	Berlin.
	29.34605	46 26 35.1	17 46 23.4	+14.2	17.9	Vienna, mean of 2 obs.
	30.54952	46 23 27.2	17 52 14.6	+ 8.6	(28.9)	Oxford, mean of 2 obs.
	31.38608	46 21 37.5	17 56 9.0	+11.0	22.4	Bilk.
1853, Jan.	1.31508	46 20 5.1	18 0 38.5	+12.0	18.6	"
	1.40786	46 19 53.3	+18 1 6.0	+16.6	—19.9	Berlin.

Resultant normal place, 1852, Dec. 24.5, Berl. m. time, 46° 48' 52".37 +17° 25' 6".67

Berlin Mean Time.		Observed		C. — O.		Place of Observation.
	^d	⊙ α	⊙ δ	Δ α	Δ δ	
1853, Feb.	28.34083	58° 24' 48".3	+24° 24' 13".6	(+10.5)	—32.6	Cambridge (Eng.), 12 comp.
March	1.32566	58 48 40.5	24 31 16.8	—10.2	(—39.0)	Hamburg.
	3.39607	59 39 3.6	24 45 35.0	— 8.4	—28.2	Senftenberg.
	5.30801	60 26 47.1	24 58 44.1	—11.8	—23.3	"
	5.34699	60 27 44.4	+24 59 5.5	—10.4	—28.6	Vienna.

Berlin Mean Time		Observed		C. — O.		Place of Observation.
		23 α	23 δ	$\Delta \alpha$	$\Delta \delta$	
1853, March	10.29855 ^d	62° 36' 59"	+25° 32' 31.6"	—14.5"	—21.3"	Vienna.
	10.31160	62 36 20.7	25 32 39.8	— 8.4	27.3	Senftenberg.
	10.39445	62 38 47.6	25 33 11.0	(—23.0)	25.4	Hamburg.
	11.35932	63 4 19.0	25 39 33.3	— 6.6	25.0	Senftenberg.
	11.36197	63 1 23.2	25 39 32.8	— 6.5	23.4	Liverpool, mean of 2 obs.
	12.35958	63 31 26.8	25 46 2.5	—14.3	20.8	Senftenberg.
	12.38025	62 32 1.9	25 46 8.2	—18.4	18.4	Hamburg.
	12.40519	62 32 35.4	25 46 18.2	— 9.0	18.6	Berlin.
	13.31467	63 57 17.5	+25 52 16.0	— 3.1	—22.0	Vienna.

Resultant normal place, 1853, March 9.5, Berl. m. time, $62^{\circ} 15' 55''.05$ $+25^{\circ} 27' 21''.84$

Berlin Mean Time.		Observed.		C. — O.		Place of Observation.
		23 α	23 δ	$\Delta \alpha$	$\Delta \delta$	
1854, May	12.50082 ^d	15 20 19.81 ^{h m s}	—13° 32' 39.1"	+3.45 ^s	—17.1"	Berlin.
	13.49668	15 19 18.67	13 32 35.0	3.43	14.2	"
	19.47087	15 13 18.87	13 32 36.1	2.76	16.3	"
	20.50419	15 12 18.40	13 32 49.6	2.63	12.7	"
	21.51154	15 11 19.78	13 33 5.2	2.84	9.8	"
	21.64109	15 11 12.24	13 33 3.9	2.92	12.9	Washington, mean of 2 obs.
	22.67227	15 10 13.19	13 33 22.6	3.02	10.8	"
	27.67529	15 5 39.88	—13 35 32.6	+3.00	—11.3	" mean of 2 obs.

Resultant normal place, 1854, May 17.5, Berl. m. time, $228^{\circ} 48' 56''.03$ $-13^{\circ} 32' 24''.77$

Berlin Mean Time.		Observed.		C. — O.		Place of Observation.
		23 α	23 δ	$\Delta \alpha$	$\Delta \delta$	
1855, July	19.53096 ^d	313° 1' 59.7"	—30° 20' 44.7"	—1' 24.0"	—22.6"	Berlin.
	23.53580	312 6 46.1	—30 42 21.1	—1 28.5	—16.6	"

Resultant normal place, 1855, July 21.5, Berl. m. time, $312^{\circ} 33' 49''.74$ $-30^{\circ} 31' 46''.10$

The elements to be finally corrected are for 1854, Jan. 0.0, Berlin mean time, and the mean equinox of the epoch

$$\begin{aligned}
 M &= 50^{\circ} 24' 55.4'' \\
 \pi &= 123 12 53.4 \\
 \Omega &= 67 55 59.6 \\
 i &= 10 13 56.3 \\
 \varphi &= 13 37 31.1 \\
 \log a &= 0.4193643 \\
 \log \mu &= 2.9209601 \\
 \mu &= 833''.6016
 \end{aligned}$$

The computation of the normal places from these elements, and with the perturbations by *Jupiter* and *Saturn*, gave the residuals

$$\begin{array}{rcl}
 \Delta \alpha \cos \delta & & \Delta \delta \\
 - 2.51 & & - 6.36 \\
 - 13.43 & & - 2.84 \\
 + 3.81 & & - 0.13 \\
 -429.06 & & -68.90
 \end{array}$$

$$\begin{array}{rclcl}
 x - x_0 & +1748 & +1388 & +522 & +17407 \\
 y - y_0 & +1664 & + 760 & + 95 & + 361 \\
 z - z_0 & + 331 & + 60 & - 25 & + 497
 \end{array}$$

The differential coefficients (the corrections of which were proved by a computation of the normals from varied elements) were then determined, and the following equations of condition obtained:—

$$\begin{array}{rclclclcl}
 0 = - 2.51 & +1.77889 d M & -2.77279 d \varphi & +1.35543 d \pi & +0.10014 d \Omega & +0.00567 d i & -7.39892 (100) d \mu \\
 0 = - 13.43 & +1.21362 & -1.40709 & +0.81244 & +0.04399 & -0.15287 & -4.35167 \\
 0 = + 3.81 & +1.35615 & +2.72459 & +1.44772 & +0.09241 & +0.18179 & +1.77435 \\
 0 = -429.06 & +0.90004 & -0.12023 & +1.41315 & -0.04849 & +0.22096 & +5.25090
 \end{array}$$

$0 = -6.36$	$+0.91253 dM$	$-1.31712 d\varphi$	$+0.67660 d\pi$	$-0.26568 d\Omega$	$-0.01188 di$	$-3.61604(100) d\mu$
$0 = -2.84$	$+0.54250$	-0.50037	$+0.35260$	-0.15449	$+0.39898$	-1.76614
$0 = -0.13$	-0.63823	-1.27715	-0.67268	$+0.25849$	$+0.39027$	-0.77478
$0 = -68.90$	$+0.17137$	$+0.04839$	$+0.26964$	$+0.13448$	-1.17751	$+0.85027$

Reducing these eight equations by the Method of Least Squares, we obtain

$0 = +8.85051 dM$	$-3.70334 d\varphi$	$+7.91668 d\pi$	$-0.15496 d\Omega$	$+0.02469 di$	$-14.92861(100) d\mu$	-420.837
$0 = -3.70334$	$+20.72500$	-1.32230	$+0.02167$	-0.07127	$+37.51870$	$+94.454$
$0 = +7.91668$	-1.32230	$+7.69747$	-0.13512	$+0.01153$	-5.89361	-638.937
$0 = -0.15496$	$+0.02167$	-0.13512	$+0.20221$	-0.11603	$+8.12466$	$+13.144$
$0 = +0.02469$	-0.07127	$+0.01153$	-0.11603	$+1.80348$	$+0.14080$	-12.052
$0 = -14.92861$	$+37.51870$	-5.89361	$+0.12466$	$+0.14080$	$+121.91680$	-2199.634

$$[ns] = -3163.888 \quad [as] = -1.99509 \quad [bs] = +53.16862 \quad [cs] = +8.27459 \quad [ds] = -0.05759$$

$$[es] = +1.79323 \quad [fs] = +138.879$$

These final equations give as the corrections of the elements

$$dM = +3' 20''.78 \quad d\varphi = -1' 38''.89 \quad d\pi = -1' 27''.85 \quad d\Omega = -1''.60 \quad di = -5''.08 \quad d\mu = +0''.68823$$

and substituting these in the original equations of condition, we have

$\Delta u \cos \delta$	$\Delta \delta$
$+0''.09$	$+0''.07$
-0.90	$+1.71$
$+0.24$	$+0.63$
-0.15	$+0.91$

Hence the corrected elements of *Thalia* for 1854, Jan. 0.0, Berlin mean time, referred to the mean equinox of the epoch, are

$$\begin{aligned} M &= 50^\circ 28' 16''.2 \\ \pi &= 123 \ 11 \ 25.5 \\ \Omega &= 67 \ 55 \ 55.0 \\ i &= 10 \ 13 \ 51.2 \\ \varphi &= 13 \ 35 \ 52.2 \\ \mu &= 834.29283 \\ \log \mu &= 2.9213184 \\ \log a &= 0.4191255 \end{aligned} \left. \vphantom{\begin{aligned} M \\ \pi \\ \Omega \\ i \\ \varphi \\ \mu \\ \log \mu \\ \log a \end{aligned}} \right\} \text{m. eq. ep.}$$

Cambridge, 1856, November 8.

FROM A LETTER OF PROFESSOR CHALLIS TO THE EDITOR.

Cambridge Observatory, 1856, November 14.

I HAVE added to this letter a list of the corrections which the indications of our mural circle require for various zenith-distances, freed as much as possible from all disturbing causes except the mere effect of imperfect rigidity. The microscopes correct, I have no doubt, in a great degree for the changes of form to which the material of the circle is liable from its own weight and that of the telescope-tube. The quantities I have obtained are corrections for residual errors which six microscopes do not eliminate. Errors of graduation are excluded, because in the circle readings for two pointings in opposite

directions the same divisions are bisected, and consequently such errors disappear in the difference of the two readings. My greatest difficulty has been to get rid of errors arising from changes of temperature, which sensibly affected both the material of the circle and that of the arms which supported the collimators. I succeeded at length by the following precautions: all the shutters of the room were left open a considerable time before commencing the measures; the clamping rods of the collimators' supports were of wood instead of metal, and their points of attachment were firmly connected with the

circle pier; and in the reduction of the observations each collimation was compared with a preceding and a following one, in order to eliminate errors from slow changes affecting the direction of collimation, which were in fact of perceptible magnitude. It is my intention to communicate all the details of this experiment to the Astronomical Society, it being, I believe, the first of the kind. In the mean while, the particulars I have mentioned, together with the knowledge you have of the experiment from having seen the apparatus, and the mode of using it, when you were here, will enable you to judge of the value and trustworthiness of the results. It is a matter of gratification to me to find that a circle eight feet in diameter is liable to so small an amount of error from flexure of the material. I have been also much pleased with the accuracy attainable in microscopic bisectors, the means of two sets of six microscope-readings, taken one a short interval after the other, never differing so much as one tenth of a second.

Results of an Experiment made to determine the Corrections to be applied to the Mean of the Microscopic Readings of the Mural Circle of the Cambridge Observatory, in order to eliminate completely the Effect of the Flexure of the Instrument.

Two collimators, mounted on arms and movable about a horizontal axis, were first made to collimate with each other for a given zenith-distance, and then the circle telescope was made to collimate alternately with the two collimators several

times in succession. The mean difference of the circle-readings for the opposite pointings being calculated, half the difference between this mean and 180° is the required amount of correction. It was found that the subjoined corrections are required to be applied to observations of *North Polar Distance*.

Zen. Dist. South.	Correction.	Zen. Dist. North.	Correction.
90°	—0.50	0°	—0.08
80	—0.61	10	+0.13
70	—0.33	20	+0.27
60	+0.19	30	+0.29
50	+0.21	40	+0.11
40	+0.32	50	+0.16
30	+0.18	60	+0.43
20	+0.34	70	+0.26
10	—0.14	80	+0.38
0	—0.08	90	+0.49

I have made an incidental use of the collimators to determine the law of flexure of a loaded beam for different angular positions. The weight of each collimator is 20 lbs., and the distance of its center of gravity from the axis of support, about 5 feet. The variations of flexure were measured by the variations of the micrometer-readings for the collimation in the different positions. I found that the law of flexure was approximately $A \sin Z$, but much more exactly $A \sin Z + B \sin^2 Z$; Z being the angular deviation from the vertical.

JAMES CHALLIS.

LETTER FROM REV. GEORGE JONES, U. S. N., TO THE EDITOR.

Quito, Ecuador, November 18, 1856.

You are, perhaps, aware that I am spending at this place the time occasionally allotted to officers of the Navy, after a long cruise; and that I am continuing here a series of observations on the Zodiacal Light, commenced in the seas of China and Japan.

The advantages of this place are very great. 1st. I have the ecliptic vertical to me, at some one hour, every night in the year. 2dly. The ecliptic can never, at the furthest, make an angle of less than 66° with my horizon; and therefore the Zodiacal Light must always present itself favorably for observation. 3dly. The transparent atmosphere of this elevated plateau allows me to see objects in the sky with a wonderful degree of distinctness. Hence the distinctive features in every change of the Zodiacal Light can be marked, here, with an exactness that I never witnessed before.

My observations are made on the summit of the hill Ychimbía, immediately adjoining Quito on the east, a place where I have horizons sufficiently open and clear.

It is not my present object to give details of observations,

but simply to notice one result, and to offer some queries to which it seems to lead, in hope of now drawing attention to the subject, and perhaps of inducing other observers to give it their particular notice. *I see here every night, and all through the night, a luminous arch, from east to west, quite across the sky.* This arch, 20° wide, is visible at all hours, when the sky is clear, but is brightest and most striking when the ecliptic is vertical; at which times it looks almost like another Milky Way. It is very evidently the Zodiacal Light. This luminous arch, I know, is not a new discovery, for Baron Humboldt saw it in the seas off Mexico, and Professor Brorsen has noticed it more fully in Germany. I also had glimpses of it in my late cruise in the Eastern seas. Here, however, it is developed with a remarkable degree of distinctness, and I am giving it particular attention. I am the more interested in it, from a suspicion which has arisen in my mind, that it is an independent light; that is, that the nebulous substance from which it comes is self-luminous, though also capable of giving us reflected light. This is only yet a surmise, for my observations,

of only eleven weeks' continuance. (I have forty-four degrees of this arch recorded,) are yet too few to warrant more than this; and we must have numerous data before we can decide affirmatively on so important a subject. My chief grounds for this surmise now are, — 1st, that, while the Zodiacal Light, near the horizon (where it obviously is chiefly a reflected light), changes decidedly according to my change of place, as regards the ecliptic, and has a strong reference to my position, the light of the Luminous Arch has not so much reference to this position; 2dly, that, while the Zodiacal Light near the horizon has a warm, sunny tinge, the light in the Luminous Arch is a cold, white light, resembling that of the Milky Way; and 3dly, that, while the Zodiacal Light over the horizon tapers off in intensity as it ascends upwardly, this of the Luminous Arch, after this other ceases, is uniform quite across the sky.

All this, however, as you will perceive, is ground only for surmise, and can now only sharpen observation; and it is a subject in which it will not do to hasten to conclusions.

Allow me, in this connection, to throw out some queries suggested in part by this, and in part by other things which I have seen at this place. — The thinness of the air on this plateau, by which, during the day, objects a great way off are seen with remarkable distinctness, and seem to be near by, might be expected to assist in atmospheric developments of several kinds unusual at other places; and such is also the fact. A phenomenon, which has sometimes drawn the attention of philosophers, namely, a general brightness in the air, at night, without any apparent cause for it, is, in some nights, very remarkable here. I find it has been noticed by others as well as myself. The brightness, without moon, or any assignable reason, has been so great, at times, that I have taken out printed papers or books, to ascertain whether I could not see to read by it.

Now, the queries that all this subject appears to suggest to us are these: — 1st. May not self-luminosity be an inherent principle of nebulous matter? 2dly. May not all space be occupied by nebulous matter, diffused around in various degrees of tenuity, but mostly so thin as to be imperceptible, except in its occasional retardation of heavenly bodies; and, as a part of

that query, is it not the cause of this well-ascertained retardation? 3dly. May not the light of what we call nebulae be from such self-luminous nebulous matter, with stars or suns, its product, but not having absorbed it all, shining in its midst? 4thly. May not the light of our Milky Way itself be, in part, from such self-luminous nebulous matter, there collected in greater quantities than in other portions of our sky? In this case, the changes known in the Galaxy, and sometimes called by astronomers "the breaking up of the Milky Way," will not be a change in stars, but in the less stable substance from which stars and systems of worlds are made.

I offer all this as merely a subject for query; and perhaps even such queries are too bold for the data which we now possess.

In connection with my observations at this place, E. C. HERRICK, Esq., at New Haven, Connecticut, Dr. DRAYTON, U. S. Navy, now on board the *St. Mary's*, at Panama, and Professor MOESTA, of the National Observatory at Santiago, Chili, are making simultaneous observations on the Zodiacal Light, on the 1st, 10th, and 15th of each month, each being furnished with star-charts; and we may thus hope for a tolerably full set of results.

In conclusion, allow me to express my regret that there is not an astronomical observatory at or near this place. It seems to me that the whole world should bestir itself, at once, to have one here. It is worthy of a world's union. Or if that cannot be done, why will not some wealthy individual or individuals see it accomplished? There is much cloudy weather here; but when the nights are clear, they have a most surprising brilliancy, the smaller stars coming out so as to fairly crowd the firmament, and the Milky Way appearing with a brightness, and apparently a nearness, that are wonderful to behold. I have no doubt that an observatory here, even if the instruments were not of very extraordinary power, would make very interesting revelations in this science. The climate here is agreeable and healthy; living is very cheap; the government of Ecuador, to my knowledge, would be very glad to co-operate in such a matter, though they have themselves not the means. Why cannot it be done?

GEORGE JONES.

OBSERVATIONS OF ALGOL-MINIMA.

By J. FOSTER FLAGG,

ASSISTANT U. S. NAVAL ASTRONOMICAL EXPEDITION.

THE following observations of the minima of *Algol* were made with a small but very good opera-glass, — as I have found the results thus obtained much more satisfactory than

those by the unaided eye. — I place but little confidence in the observations of Oct. 2.

1856, Oct. 2.

Perfectly clear.

Time by Watch.	Relative Brightness.	Time by Watch.	Relative Brightness.
^h ^m 9 43.5	$\beta = \varrho + 1\frac{1}{2}$	^h ^m 10 30	$\beta = \varrho + \frac{1}{4}$
46.5	$= \varrho + 1$	32	$= \varrho + \frac{1}{2}$
50.5	$= \varrho + \frac{1}{2}$	46	$= \varrho + 1$
9 55.0	$= \varrho + \frac{1}{4}$	10 50	$\beta = \varrho + 1\frac{1}{2}$
10 10.0	$\beta = \varrho +$		

Observed times,	^h ^m 10 16.75
	16.25
	11.25
	10 12.50
Mean,	10 14.19
Correction for watch error,	+ 0.06
Resulting minimum,	10 14.25 Washington M. T.

1856, Nov. 8.

Very clear, but approaching dawn at the close ; during the latter observations, * rather near the horizon.

Time by Watch.	Relative Brightness.	Time by Watch.	Relative Brightness.
^h ^m 16 9	$\beta = \varrho + 2\frac{1}{2}$	^h ^m 16 57	$\beta = \varrho + \frac{1}{2}$
12	$\beta = * - 2$	5	$\beta = \varrho + \frac{3}{4}$
17	$= \varrho + 2 +$	12	$= \varrho + 1\frac{1}{2}$
18	$= * - 2$	20	$= \varrho + 2$
25	$= \varrho + 1\frac{1}{2}$	27	$= \varrho + 2 +$
30	$= \varrho + 1$	17 32	$\beta = \varrho + 2\frac{1}{2}$
16 35	$\beta = \varrho + \frac{1}{2}$		

Observed times by ϱ .	Observed times by *.
^h ^m 16 50.5	^h ^m 16 47.5
52.0	48.5
48.5	16 47.5
16 46.0	Mean, 16 47.83 (weight, 1.)
Mean, 16 49.25 (weight, 3.)	
Resulting mean,	^h ^m 16 48.9
Correction for watch error,	+ 1.4
Resulting minimum,	16 50.3 Washington M. T.

1856, Dec. 7.

Very clear, but bright moonlight.

Time by Watch.	Relative Brightness.	Time by Watch.	Relative Brightness.
^h ^m 8 13	$\beta = \varrho + \frac{1}{4}$	^h ^m 8 53	$\beta = \varrho - \frac{3}{4}$
21	$= \varrho + \frac{1}{4}$	0	$= \varrho - \frac{1}{4}$
25	$= \varrho$	7	$= \varrho - \frac{1}{2}$
33	$= \varrho - \frac{1}{4}$	16	$= \varrho - \frac{1}{4}$
39	$= \varrho - \frac{1}{2}$	23	$= \varrho$
8 46	$\beta = \varrho - \frac{1}{2}$	9 33	$\beta = \varrho + \frac{1}{4}$

Observed times for ϱ .

^h ^m 8 53.00
54.00
54.50
54.75
8 56.50

Mean, 8 54.95 (weight, 2.)

Observed times for δ .

^h ^m 8 59.00
56.25
57.75
8 56.50

Mean, 8 57.37 (weight, 1.)

Resulting mean,	^h ^m 8 55.76
Correction for watch error,	+ 0.66
Resulting minimum,	8 56.42 Washington M. T.

1856, Dec. 30.

The night still and perfectly clear.

Time by Watch.	Relative Brightness.	Time by Watch.	Relative Brightness.
^h ^m 6 48	$\beta = \varrho + 1\frac{1}{2}$	^h ^m 7 42	$\beta = \varrho + \frac{1}{2}$
6 55	$= \varrho + 1\frac{1}{4}$	50	$= \varrho + \frac{3}{4}$
7 2	$= \varrho + 1$	7 58	$= \varrho + 1$
11	$= \varrho + \frac{1}{2}$	8 5	$= \varrho + 1\frac{1}{4}$
19	$= \varrho + \frac{1}{4}$	8 13	$\beta = \varrho + 1\frac{1}{2}$
7 35	$\beta = \varrho + \frac{1}{4}$		

Observed times by ϱ .

^h ^m 7 30.5
30.0
30.0
26.5
7 27.0

Mean, 7 28.8 (weight, 2.)

Observed times by δ .

^h ^m 7 32.25
28.00
7 26.75

Mean, 7 29.00 (weight, 1.)

Resulting mean,	^h ^m 7 28.87
Correction for watch error,	- 1.89
Resulting minimum,	7 26.98 Washington M. T.

I made also the following notes concerning the brightness of ϱ Persei, at the minima of *Algol*, showing plainly its variability.

1856, Oct. 2. — *Algol* at its minimum slightly brighter than ϱ Persei.

1856, Nov. 8. — *Algol* $\frac{1}{4}$ measure brighter than ϱ Persei.

1856, Dec. 7. — ϱ Persei $\frac{3}{4}$ measure brighter than *Algol*.

1856, Dec. 30. — *Algol* a little brighter than ϱ Persei.

OBSERVATIONS OF ALGOL-MINIMUM.

MADE AT WELD, FRANKLIN COUNTY, MAINE.—Lat. 44° 45' N. Long. 70° 23' W.

By STILLMAN MASTERMAN.

The sky was clear and moonlight bright.

1856, Dec. 7.

Time by Watch.	Comparison.		Time by Watch.	Comparison.	
	δ	q		δ	q
^h ^m			^h ^m		
8 28	β 1 δ	β 3 q	9 29	δ 2 β	$\beta = q$
33	1	3	32	2	$\frac{1}{2}$
38	1	$2\frac{1}{2}$	37	2	$\frac{1}{2}$
43	=	2	40	2	$\frac{1}{2}$
48	=	2	47	1	1
53	=	$1\frac{1}{2}$	51	1	1
8 58	δ 1 β	$1\frac{1}{2}$	9 55	1	$1\frac{1}{2}$
9 3	1	1	10 0	=	2
8	1	1	5	=	2
12	2	$\frac{1}{2}$	10	=	$2\frac{1}{2}$
16	2	=	15	β 1 δ	3
20	2	=	10 18	β 1 δ	β 3 q
9 24	δ 2 β	$\beta = q$			

Time of minimum by comparison with δ : —

$$\left. \begin{array}{l} 9 \text{ }^{\text{h}} 24.75 \\ 26.50 \\ 27.00 \\ 9 \text{ }^{\text{h}} 26.25 \end{array} \right\} 9 \text{ }^{\text{h}} 26.12$$

Resulting time of minimum,
Watch fast,
Concluded minimum, Dec. 7,

with q : —

$$\left. \begin{array}{l} 9 \text{ }^{\text{h}} 23.50 \\ 24.00 \\ 24.00 \\ 25.25 \\ 27.25 \\ 24.16 \\ 9 \text{ }^{\text{h}} 22.25 \end{array} \right\} 9 \text{ }^{\text{h}} 24.34$$

$$\begin{array}{r} 9 \text{ }^{\text{h}} 25.23 \\ 0.69 \\ \hline 9 \text{ }^{\text{h}} 24.54 \text{ Weld M. T.} \end{array}$$

ELEMENTS AND EPHEMERIS OF ISIS.

By TRUMAN HENRY SAFFORD.

[Communicated by Professor WINLOCK, Superintendent American Ephemeris.]

THE Elements are from observations, Oxford, May 28th ;
Berlin, July 27th ; Cambridge, September 25th (unpublished,
and for which I am indebted to the kindness of Mr. Bond).

Epoch 1856, July 29.0.

M	326	11	41.1	} Mean Equinox of 1856.0.
ω	233	35	10.5	
Ω	84	28	16.4	
φ	12	59	9.5	
i	8	34	26.7	
μ	15	32.996		

The perturbations by Mars, Jupiter, and Saturn have been
computed as follows (expressed in seconds), by Mechanical
Quadratures : —

1857, Nov. 21.				1857, Dec. 31.	
δx	+233.87	40 $D t \delta x$	+81.37	δx	+318.29
δy	205.70	40 $D t \delta y$	60.45	δy	274.44
δz	+104.98	40 $D t \delta z$	+24.39	δz	+132.43

where x, y, z are the common co-ordinates referred to the equator.
From these have been computed the following ephemerides : —

EPHEMERIS OF ISIS FOR 1857.

Washington Mean Noon.

Date.	$\odot \alpha$	$\odot \delta$	Log Δ	Log r	Date.	$\odot \alpha$	$\odot \delta$	Log Δ	Log r
	^h ^m	[°] [']				^h ^m	[°] [']		
Jan. 0	21 4.9	—22 26.4	0.4237	0.2774	July 9	3 50.3	+15 0.2	0.4408	0.3475
10	21 30.0	20 39.8	0.4327	0.2788	19	4 7.9	15 57.0	0.4302	0.3525
20	21 54.7	18 42.0	0.4409	0.2804	29	4 24.4	16 44.7	0.4181	0.3574
30	22 18.8	16 35.1	0.4484	0.2825	Aug. 8	4 40.1	17 24.0	0.4042	0.3622
Feb. 9	22 42.4	11 21.7	0.4551	0.2849	18	4 54.6	17 55.8	0.3887	0.3670
19	23 5.5	12 2.2	0.4609	0.2876	28	5 7.8	18 21.1	0.3715	0.3717
Mar. 1	23 28.1	9 40.1	0.4659	0.2906	Sept. 7	5 19.6	18 11.2	0.3527	0.3763
11	23 50.2	7 16.7	0.4702	0.2940	17	5 29.3	18 57.5	0.3326	0.3809
21	0 11.9	4 53.9	0.4734	0.2977	27	5 36.9	19 11.3	0.3114	0.3854
31	0 34.3	2 33.0	0.4759	0.3016	Oct. 7	5 42.0	19 24.6	0.2894	0.3898
Apr. 10	0 54.3	— 0 15.6	0.4773	0.3057	17	5 44.2	19 38.5	0.2675	0.3941
20	1 15.1	+ 1 57.1	0.4778	0.3100	27	5 43.2	19 54.0	0.2469	0.3983
30	1 35.6	4 3.6	0.4773	0.3144	Nov. 6	5 38.2	20 11.2	0.2288	0.4024
May 10	1 55.8	6 3.3	0.4758	0.3188	16	5 31.6	20 29.4	0.2153	0.4064
20	2 15.7	7 52.2	0.4731	0.3233	26	5 21.8	20 50.7	0.2077	0.4103
30	2 35.4	9 38.7	0.4692	0.3279	Dec. 6	5 10.5	21 9.5	0.2076	0.4141
June 9	2 54.7	11 13.2	0.4642	0.3326	16	4 59.0	21 26.6	0.2154	0.4178
19	3 13.7	12 38.4	0.4578	0.3375	26	4 48.7	21 42.5	0.2305	0.4213
29	3 32.3	+13 54.0	0.4500	0.3425	36	4 40.7	+21 58.4	0.2517	0.4246

EPHEMERIS FOR THE OPPOSITION.

Washington Mean Noon.

1857.	$\odot \alpha$	$\odot \delta$	Log Δ	1857.	$\odot \alpha$	$\odot \delta$	Log Δ
	^h ^m ^s	[°] ['] ["]			^h ^m ^s	[°] ['] ["]	
Nov. 21	5 26 56.87	+20 40 54.9	0.210630	Dec. 12	5 3 30.85	+21 19 57.1	0.211351
22	25 56.93	42 53.3	0.209908	13	2 22.28	21 38.2	0.212245
23	24 55.81	44 51.4	0.209259	14	1 14.20	23 18.4	0.213217
24	23 53.56	46 49.1	0.208683	15	5 0 6.69	24 57.7	0.214265
25	22 50.27	48 46.4	0.208179	16	4 58 59.83	26 36.1	0.215389
26	21 46.07	50 43.2	0.207748	17	57 53.70	28 13.7	0.216587
27	20 40.97	52 39.4	0.207391	18	56 48.37	29 50.6	0.217858
28	19 35.06	54 34.9	0.207119	19	55 43.93	31 26.9	0.219201
29	18 28.41	56 29.7	0.206904	20	54 40.45	33 2.8	0.220615
30	17 21.10	20 58 23.7	0.206775	21	53 38.00	34 38.2	0.222099
Dec. 1	16 13.20	21 0 16.9	0.206723	22	52 36.63	36 13.3	0.223652
2	15 4.81	2 9.2	0.206749	23	51 36.41	37 48.1	0.225271
3	13 55.99	4 0.6	0.206853	24	50 37.42	39 22.6	0.226956
4	12 46.82	5 50.9	0.207036	25	49 39.70	40 57.0	0.228704
5	11 37.39	7 40.3	0.207298	26	48 43.30	42 31.3	0.230514
6	10 27.78	9 28.6	0.207639	27	47 48.27	44 5.6	0.232384
7	9 18.06	11 15.9	0.208059	28	46 51.65	45 40.0	0.234314
8	8 8.32	13 2.2	0.208560	29	46 2.49	47 14.6	0.236299
9	6 58.65	14 47.4	0.209110	30	45 11.86	48 49.5	0.238338
10	5 49.12	16 31.7	0.209798	31	4 41 22.78	+21 50 24.8	0.240430
11	5 4 39.82	+21 18 14.9	0.210536				

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NO. 5.

OBSERVATIONS OF IRENE, MELPOMENE, AND MASSALIA.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Lieutenant MAURY. — Corrected for refraction.]

I R E N E.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑭ — *		⑭'s apparent	
				$\Delta \alpha$	$\Delta \delta$	α	δ
1856, Aug. 9	^h 11 ^m 42 ^s 29.1	7	A. Z. 248, 46	^m ^s +0 26.25	+ 3' 46.30	^h ^m ^s 22 37 15.76	—21° 38' 3.01
		7	" 248, 47	—0 17.29	— 0 45.02	22 37 15.72	21 38 2.01
	24 9 56 47.1	16	" 257, 37	+0 45.20	+ 8 47.69	22 24 28.54	23 15 34.44
	25 9 35 4.6	16	" 257, 37	—0 7.98	+ 3 13.10	22 23 35.37	23 21 8.11
	26 10 28 0.8	6	" 257, 37	—1 4.17	— 2 33.03	22 22 39.18	23 26 54.28
	29 10 20 31.2	10	" 257, 30	+1 48.29	— 3 29.45	22 19 58.70	23 42 33.86
	30 9 33 29.4	8	" 257, 30	+0 56.59	— 8 14.79	22 19 7.01	23 47 19.30
Sept. 2	9 31 51.7	16	" 257, 28	—0 10.67	+ 4 25.32	22 16 28.56	24 1 2.56
	3 9 38 48.7	10	" 257, 28	—1 2.95	+ 0 7.51	22 15 36.28	24 5 20.43
	7 8 11 38.1	16	" 257, 23	+0 47.26	+10 47.28	22 12 18.49	24 20 20.92
	10 9 18 14.2	10	" 257, 23	—1 38.95	+ 1 7.33	22 9 52.27	24 30 1.09
	14 9 20 47.9	4	" 257, 16	+0 4.83	+ 2 44.57	22 6 51.60	24 40 3.07
	15 9 25 0.1	16	" 257, 16	—0 37.72	+ 0 42.82	22 6 9.06	—24 42 4.90

Adopted Mean Places, 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
A. Z. 248, 46	9	^h ^m ^s 22 36 59.36	—21° 40' 49.54	} Argelander's Zones.
" 248, 47	9	22 37 42.86	21 36 17.33	
" 257, 37	9	22 23 53.08	23 23 21.97	
" 257, 30	9	22 18 20.16	23 38 5.28	
" 257, 28	8	22 16 48.98	24 4 28.62	
" 257, 23	8.9	22 11 41.01	24 30 8.88	
" 257, 16	7	22 6 56.61	—24 41 48.07	

M E L P O M E N E.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑮ — *		⑮'s apparent	
				$\Delta \alpha$	$\Delta \delta$	α	δ
1856, Sept. 25	^h 11 ^m 3 ^s 18.8	15	Weisse II. 831	^m ^s —0 20.88	—6' 56.72	^h ^m ^s 2 47 33.23	—0° 15' 18.01
	27 10 52 14.6	12	" 820	+0 5.42	—0 58.82	2 47 33.58	—0 38 53.32
Oct. 3	10 24 14.3	5	" 762	+2 32.00	—5 13.45	2 46 42.13	—1 50 22.52

Date.	M T. Washington.	No. of Comp.	Comparison-Star.	⑮ — *		⑮'s apparent	
				$\Delta \alpha$	$\Delta \delta$	α	δ
1856, Oct. 6	^h 9 ^m 57 ^s 21.8	15	Lalande 5358	—0 ^m 32.59	—12' 27.48	^h 2 ^m 45 ^s 47.65	—2° 26' 0.69
9	9 55 38.9	6	Weisse II. 802	—2 1.16	—16 5.38	2 44 35.53	3 1 25.83
		6	" 825	—3 4.33	—7 41.14	2 44 35.29	3 1 23.04
21	9 9 17.9	16	" 640	+0 6.86	—1 16.99	2 37 20.61	5 8 46.08
24	9 56 19.4	13	" 576	+1 37.01	+2 38.09	2 35 4.08	5 35 31.33
28	9 57 7.9	10	" 566	—1 3.86	+11 18.75	2 31 56.52	6 6 25.31
29	9 56 51.6	6	" 566	—1 51.39	+4 33.20	2 31 9.01	6 13 10.96
31	10 3 8.8	5	Σ. Cat. G. 250	+2 33.11	—9 30.78	2 29 33.51	6 25 25.86
Nov. 1	10 15 59.7	5	" 250	+1 45.33	—15 9.02	2 28 45.74	6 31 4.20
5	10 10 57.8	6	Weisse II. 437	—1 5.86	—11 6.37	2 25 41.04	6 49 12.73
10	9 51 12.3	14	" 386	—1 8.64	—4 37.12	2 22 6.29	7 2 29.51
18	7 36 5.4	9	" 250	+1 7.45	—11 26.50	2 17 24.00	7 1 59.53
19	9 9 0.7	6	" 250	+0 39.20	—9 37.71	2 16 55.78	7 0 10.84
Dec. 7	8 29 22.6	4	" 168	+2 9.07	+5 23.93	2 13 30.45	5 26 29.58
		4	" 185	+1 0.75	+13 3.03	2 13 31.39	5 26 25.39
9	8 41 52.6	4	" 168	+2 25.31	+21 42.91	2 13 46.69	5 10 10.81
11	9 32 56.2	10	B. A. C. 722	+1 41.06	+7 44.32	2 14 11.51	—4 52 40.42

Adopted Mean Places, 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
Weisse II. 831	7	^h 2 ^m 48 ^s 3.41	—0° 7' 45.57	Weisse's Catalogue.
" 820	7	2 47 37.42	0 37 18.91	Santini's and Weisse's Catalogues.
" 762	9	2 44 19.20	1 44 32.46	Weisse's Catalogue.
Lalande 5358	8	2 46 29.23	2 12 57.52	Lalande's Catalogue.
Weisse II. 802	9	2 46 45.60	2 44 44.84	Weisse's Catalogue.
" 825	9	2 47 48.53	2 53 3.77	" "
" 640	8.9	2 37 22.25	5 6 50.98	" "
" 576	8	2 33 35.58	5 37 30.34	" "
" 566	9	2 33 8.82	6 17 4.51	" "
Σ. Cat. G. 250	8 ⁽¹⁾	2 27 8.82	6 15 13.94	Struve's Catalogus Generalis.
Weisse II. 437	8	2 26 55.26	6 37 24.58	Weisse's Catalogue.
" 386	9	2 23 23.25	6 57 9.44	" "
" 250	7.8	2 16 24.86	6 49 47.82	" "
" 168	8	2 11 29.80	5 31 5.77	" "
" 185	9	2 12 39.07	5 38 40.68	" "
B. A. C. 722	7	2 12 38.91	—4 59 36.78	B. A. Catalogue.

MASSALIA.

Date.	M T. Washington	No. of Comp.	Comparison-Star.	⑳ — *		⑳'s apparent	
				$\Delta \alpha$	$\Delta \delta$	α	δ
1856, Nov. 11	^h 9 ^m 34 ^s 5.9	6	Weisse II. 470	+0 ^m 47.89	—11' 29.52	^h 2 ^m 29 ^s 10.08	+14° 20' 2.90
12	8 37 51.5	12	" 470	—0 6.12	—16 16.35	2 28 16.08	14 15 16.07
19	8 3 50.0	12	" 372	—0 37.05	+5 12.36	2 22 9.92	13 42 45.18
Dec. 26	6 35 56.5	6	" 144	+2 22.02	+1 31.95	2 12 44.33	12 47 39.04
		6	" 188	—0 7.69	—13 10.40	2 12 44.06	12 47 41.93
28	7 10 27.5	12	" 188	+0 38.68	—9 22.03	2 13 30.54	+12 51 30.32

Adopted Mean Places, 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
Weisse II. 470	8.9	^h 2 ^m 28 ^s 31.64	+14° 32' 12.58	Weisse's Catalogue.
" 373	9	2 22 56.32	13 38 13.87	
" 144	8	2 10 31.87	12 46 51.22	
" 188	9	2 13 1.31	+13 1 35.98	

(¹) The preceding star observed: corrected for $A = 3''.77$. $P = 350^\circ$.

EXTRACT FROM A LETTER OF PROFESSOR GERLING TO THE EDITOR.

Marburg (Kurhessen), 1857, January 9.

BEFORE mentioning other subjects, let me communicate to you the *immersion of α Scorpii*, which I observed with three of my pupils last summer. We found

1856, June 16.

^h	^m	^s	Sid. time	=	^h	^m	^s	M. time,	GERLING.
17	59	25.264		=	12	17	41.76		
17	59	26.264	"	=	12	17	45.76	"	REIDT.
17	59	25.764	"	=	12	17	45.27	"	BUDÉRUS.
17	59	25.764	"	=	12	17	45.27	"	MAURITIUS.

In No. 446 of the *Astronomische Nachrichten*, I communicated the examination of a Theodolite of BREITHAUP'T's, for errors of eccentricity and division, which I had undertaken with help of the late H. L. WESTPHALEN. A similar examination of a small universal instrument recently constructed by the same artist, with a horizontal circle of 67.7 Paris lines, and a vertical one of 56.9 Paris lines in diameter, was undertaken at my request last summer by Dr. REIDT, whose results were the following:—

Let a = distance from the centre of rotation of the alidade to the centre of graduation expressed in fraction of a Paris line.

" b = point of graduation belonging to the semi-diameter which joins the two centers.

" c = distance of Non. II. from Non. I. in degrees of the graduation.

Dr. REIDT found by reading both noniuses from 10° to 10° , for horizontal circle:—

1st series, $a = 0.0001582$ $b = 107^\circ 42' 30''$ $c = 180^\circ 0' 8.055$
 2d " $a = 0.0003494$ $b = 95^\circ 12' 2''$ $c = 180^\circ 0' 7.220$

For vertical circle:—

1st series, $a = 0.0005359$ $b = 119^\circ 55' 17''$ $c = 180^\circ 0' 1.889$
 2d " $a = 0.0005917$ $b = 120^\circ 48' 10''$ $c = 180^\circ 0' 0.556$

By comparing the readings with these results, the mean error of reading was found,—

For horizontal circle, 1st series, ± 10.83
 2d " ± 9.06

For vertical circle, 1st series, ± 5.12
 2d " ± 3.29

These numbers, compared with those of No. 446, *Astron. Nachr.*, show that the instruments of the artist have been since that time still improved in this point.

I avail myself of this occasion to direct your attention to an error possibly occurring in the use of small portable instruments, and of which I had no suspicion, before making experience of it last year with great loss of time and labor.— In 1840, after having obtained a portable transit-instrument (*Astron. Nachr.*, No. 458), I scrupulously examined the equality of the steel pivots of the horizontal axis, lying in its own Ys, by means of the level. A great number of observations constantly indicated a want of equality, by which the circle-end of the axis uniformly appeared to be smaller than the other one. I therefore applied the corresponding correction to all observations since that time. But having recently seen in BREITHAUP'T's universal instrument that the level indicated no inequality of pivots at all, I requested this careful artist to make the necessary improvement of the pivots of the transit. He however, after having constructed a separate pair of Ys for this purpose, and made use of the same level, informed me that he could find no such fault in it. Therefore, as comparison showed that no essential difference existed between the two pivots, except this, that BREITHAUP'T's instrument was in perfect equilibrium in all positions, while the transit axis had a considerable overweight on the circle-end, there remained only the hypothesis, that the lowering of this end might have its origin in the elasticity of the metallic parts below it.— Experiment fully proved the correctness of this hypothesis. For, after having suspended the axis in the middle, and added a counterpoise to the overweight of the circle, the error disappeared entirely. The utmost care, therefore, for perfect equilibrium is an indispensable condition for the perfect use of these small portable instruments, just as it is known to be for the great, heavy ones.

C. L. GERLING.

ON THE ORBIT OF THE SECOND COMET OF 1853.

By JOHN N. STOCKWELL.

No accurate determination of the orbit of this comet has yet been published, that I am aware of; and the present communication is designed to supply the deficiency. From observations at the Cape of Good Hope, on May 1, 11, and 21, a parabolic orbit was computed, which differed so much from elements of the same comet which were published by Dr. MOESTA (*Astronomical Journal*, Vol. III. p. 117), as to induce the supposition that the orbit differed very much from the parabolic form, or that Dr. MOESTA's elements were very far from their true values.

To test this question, and at the same time to discover the cause of the discordance, I compared the Santiago observations, which were the basis of Dr. MOESTA's elements, with my orbit. The comparison stands as follows:—

	C. — O.	
	$\Delta \alpha$	$\Delta \delta$
May 1	— 1' 30.0	— 0' 8.6
" 2	+ 53 34.7	— 8 54.6
" 3	+ 1 29.1	— 2 5.7

This comparison manifestly shows that the observation of May 2 was remarkably erroneous; and hence the cause for discordant elements is very apparent.

By the help of my parabolic elements, the observations were corrected for parallax and aberration, and the following normal places, which are referred to the mean equinox of 1851.0, were taken out.

	α	δ
Apr. 16.5	306° 54' 3.7	+ 12° 34' 19.7
May 2.0	81 11 7.5	— 13 51 43.9
May 12.0	105 18 55.5	— 13 47 55.3
May 22.0	108 55 51.0	— 13 15 34.2
June 1.0	110 11 21.7	— 12 50 12.5
June 8.0	110 41 18.9	— 12 37 5.3

The place for April 16.5 was derived from the observations of Königsberg and Hamburg of the same day; that of May 2 is derived from the observations of May 1 and 3, made at Santiago and the Cape of Good Hope; and the remaining ones are founded exclusively on the Cape observations, which are the only ones known to me made subsequently to May 3.

To determine the orbit, leaving the eccentricity indeterminate, the normal places of May 2, 22, and June 8, were selected as most appropriate, and from them the following elements were deduced, using the formulas of GAUSS.

T 1853, May 9.823475 Greenwich M. T.

Ω	40° 58' 22.1
π	201 45 47.3

Brecksville, Ohio, 1857, March 5.

i	57° 49' 6.0
$\log a$	1.8733118
" e	9.9946844
" q	9.9584212

Motion Retrograde.

These elements give the following representation of the normal places:—

	C. — O.	
	$\Delta \lambda \cos \beta$	$\Delta \beta$
Apr. 16.5	— 40.86	— 55.6
May 12.0	+ 5.72	— 2.5
" 22.0	— 0.41	— 0.7
June 1.0	— 3.87	— 0.9

It should be observed, that a very near agreement with the place of April 16.5 ought not to be expected, unless due allowance is made for the perturbations. For between that date and the earliest one used in the computation, the comet passed comparatively near the earth, and must have suffered sensible perturbations. On April 29, the heliocentric longitude of the comet was the same as that of the earth, while its heliocentric latitude was only 2° 21', and log. radius-vector 9.96714, making its distance from the earth only 0.0904 that of the earth's mean distance from the sun.

These elements bear considerable resemblance to the parabolic elements of the second comet of 1844, which are here repeated for the sake of comparison.

T 1844, Oct. 17.362

Ω	31° 34'
π	180 32
i	48 35
$\log q$	9.9335

Motion Retrograde.

But the elements I have given represent the observations too well to allow the supposition of a nine-year period. We ought, perhaps, to observe, that elements of this comet deduced from the supposition of a nine-year period are very nearly the same as the present estimated values of these elements, with the exception of the time of perihelion and eccentricity. The question of their identity is, perhaps, deserving of further discussion; and should the vicissitudes of life allow me to devote my time to astronomical investigations, I may at some future period resume this interesting subject, for the purpose of arriving at more definite conclusions respecting the real nature of the orbit.

OBSERVATIONS OF ALGOL-MINIMA.

MADE AT WELD, FRANKLIN COUNTY, MAINE.

By STILLMAN MASTERMAN.

1857, Feb. 11.

Clear and very cold.

Time by Watch.	Comparison.		Time by Watch.	Comparison.		Time by Watch.	Comparison.	
	δ	φ		δ	φ		δ	φ
^h ^m 7 12	β 1 δ	β 3 φ	^h ^m 7 57	δ 1 β	β 1 φ	^h ^m 8 42	δ 1 β	β 1 φ
7 17	1	3	8 2	2	$\frac{1}{2}$	8 47	1	1
7 22	1	3	8 7	2	$\beta = \varphi +$	8 52	1	$1\frac{1}{2}$
7 27	=	2	8 12	2	$\beta = \varphi -$	8 57	=	2
7 32	=	2	8 17	2	$\beta = \varphi +$	9 2	$\delta = \beta$	2
7 37	$\beta = \delta$	2	8 22	2	$\frac{1}{2}$	9 7	β 1 δ	3
7 42	δ 1 β	$1\frac{1}{2}$	8 27	2	$\frac{1}{2}$	9 12	β 1 δ	β 3 φ
7 47	1	1	8 32	2	$\frac{1}{2}$			
7 52	δ 1 β	β 1 φ	8 37	δ 2 β	β 1 φ			

Observed time of minimum by comparison with δ : —

$$\left. \begin{array}{l} 8 \text{ }^{h} \text{ }^{m} 13.25 \\ 8 \text{ }^{h} \text{ }^{m} 15.75 \\ 8 \text{ }^{h} \text{ }^{m} 18.25 \\ 8 \text{ }^{h} \text{ }^{m} 19.50 \end{array} \right\} 8 \text{ }^{h} \text{ }^{m} 16.69 \text{ (Weight, 1.)}$$

with φ : —

$$\left. \begin{array}{l} 8 \text{ }^{h} \text{ }^{m} 13.25 \\ 8 \text{ }^{h} \text{ }^{m} 15.75 \\ 8 \text{ }^{h} \text{ }^{m} 17.00 \\ 8 \text{ }^{h} \text{ }^{m} 17.00 \\ 8 \text{ }^{h} \text{ }^{m} 14.50 \\ 8 \text{ }^{h} \text{ }^{m} 12.00 \end{array} \right\} 8 \text{ }^{h} \text{ }^{m} 14.91 \text{ (Weight, 2.)}$$

Resulting time of minimum, ... 8 ^h ^m 15.50
 Correction for watch-error, ... — 0.75

8 ^h ^m 14.75

Longitude East from Washington, ... 26.65

Concluded minimum, Feb. 11, ... 7 48.10 Washington M. T.

1857, Mar. 6.

Sky clear, but twilight rendered the comparisons difficult before the minimum.

Time by Watch.	Comparison.		Time by Watch.	Comparison.		Time by Watch.	Comparison.	
	δ	φ		δ	φ		δ	φ
^h ^m 6 32	δ 1 β	β 1 φ	^h ^m 6 57	δ 2 β	β 1 φ	^h ^m 7 22	$\delta = \beta$	β 2 $\frac{1}{2}$ φ
6 37	1	1	7 2	1	1	7 27	=	2 $\frac{1}{2}$
6 42	2	$\frac{1}{2}$	7 7	1	$1\frac{1}{2}$	7 32	=	3
6 47	2	$\frac{1}{2}$	7 12	1	$1\frac{1}{2}$	7 37	β 1 δ	3
6 52	δ 2 β	β 2 $\frac{1}{2}$ φ	7 17	$\delta = \beta$	β 2 φ	7 42	β 1 δ	β 3 φ

Observed time of minimum by comparison with δ : —

$$\left. \begin{array}{l} 6 \text{ }^{h} \text{ }^{m} 50.75 \\ 6 \text{ }^{h} \text{ }^{m} 49.50 \end{array} \right\} 6 \text{ }^{h} \text{ }^{m} 50.13 \text{ (Weight, 1.)}$$

with φ : —

$$\left. \begin{array}{l} 6 \text{ }^{h} \text{ }^{m} 47.00 \\ 6 \text{ }^{h} \text{ }^{m} 47.00 \end{array} \right\} 6 \text{ }^{h} \text{ }^{m} 47.00 \text{ (Weight, 2.)}$$

Resulting time of minimum, ... 6 ^h ^m 48.04
 Correction for watch-error, ... — 0.82

6 ^h ^m 47.22

Longitude East from Washington, ... 26.65

Concluded minimum, Mar. 6, ... 6 20.57 Washington M. T.

AN INVESTIGATION OF THE CASES OF COMPLETE SOLUTION BY INTEGRATION BY QUADRATURES OF THE PROBLEM OF THE MOTION OF A MATERIAL POINT ACTED UPON BY FORCES WHICH EMANATE FROM A FIXED AXIS.

By BENJAMIN PEIRCE, LL.D.,

PERKINS PROFESSOR OF ASTRONOMY AND MATHEMATICS IN HARVARD UNIVERSITY.

THE equation which expresses the preservation of the area described by the projection of the radius-vector of the body upon the plane, which is perpendicular to the fixed axis, reduces this problem so that its subsequent solution depends upon only two independent variables. The preservation of living forces gives one integral which involves the two variables, and if another integral can be obtained, it is evident that, from JACOBI'S principle of the last multiplier, the complete solution can be obtained by means of quadratures. The investigation is therefore limited to the determination of the cases in which a new integral is possible. But since every function of given variables can be expressed by quadratures, whenever they themselves admit of such expression, the successful solution of the problem depends upon the choice of some function which can be readily analyzed.

The following notation may then be adopted:—

p = the half-sum of the distances of the body from any two fixed points of the axis.

q = the half-difference of these distances.

φ = the angle which the plane drawn through the fixed line and the body makes with its initial position.

a = half the distance between the assumed fixed points.

ψ = half the angle which the two lines, drawn from the body to the fixed points, make with each other.

k = the perpendicular let fall from the body upon the fixed axis.

$$\begin{aligned} p' &= D_t p, & q' &= D_t q, & \varphi' &= D_t \varphi, \\ p_1^2 &= p^2 - a^2, & q_1^2 &= a^2 - q^2, & p'' &= D_t p', \text{ \&c.} \end{aligned}$$

the values of k and ψ are

$$k = \frac{p_1 q_1}{a}, \quad \tan \psi = \frac{q_1}{p_1}$$

and the general expression for the living force of the body supposed to be the unit of mass is

$$\begin{aligned} T &= \frac{p'^2}{2 \cos^2 \psi} + \frac{q'^2}{2 \sin^2 \psi} + \frac{1}{2} k^2 \varphi'^2 \\ &= \frac{1}{2} (p_1^2 + q_1^2) \left(\frac{p'^2}{p_1^2} + \frac{q'^2}{q_1^2} \right) + \frac{p_1^2 q_1^2 \varphi'^2}{2 a^2} \end{aligned}$$

If, then,

Ω = the potential of the forces acting upon the body,

Ω is a function of p and q , and the equations of motion given by LAGRANGE'S canonical forms are

$$D_t \left(\frac{p_1^2 q_1^2 \varphi'}{a^2} \right) = D_t (k^2 \varphi') = 0$$

$$D_p \Omega = p'' \sec^2 \psi - p \frac{q'^2}{q_1^2} - \frac{p q_1^2 \varphi'^2}{a^2} - \frac{2 p_1^2 q p' q' + p q_1^2 p'^2}{p_1^4}$$

$$D_q \Omega = q'' \operatorname{cosec}^2 \psi + q \frac{p'^2}{p_1^2} + \frac{q p_1^2 \varphi'^2}{a^2} + \frac{2 q_1^2 p p' q' + q p_1^2 q'^2}{q_1^4}$$

The integral of the first of these equations is

$$p_1^2 q_1^2 \varphi' = a B$$

in which B is an arbitrary constant, and this equation expresses the preservation of areas with reference to the plane which is perpendicular to the fixed axis.

A second integral of these equations is given by the principle of living forces, which is

$$T = \Omega + H$$

in which H is an arbitrary constant.

The sum of the equations obtained by multiplying the preceding value of $D_p \Omega$ by $p_1^2 p'$, that of $D_q \Omega$ by $-q_1^2 q'$, and the equation of living forces by $2(p p' + q q')$, and adding the products, is

$$\begin{aligned} \frac{1}{2} D_t [(p^2 - q^2) (p'^2 - q'^2)] &= D_t [(p^2 + q^2 - a^2) (\Omega + H)] \\ &\quad - (q^2 p' D_p \Omega + p^2 q' D_q \Omega) \end{aligned}$$

This equation is integrable whenever Ω satisfies the equation

$$D_q (q^2 D_p \Omega) = D_p (p^2 D_q \Omega)$$

or

$$(p^2 - q^2) D_{p,q}^2 \Omega = 2 q D_p \Omega - 2 p D_q \Omega$$

The introduction of Ω_1 by the equation

$$\Omega_1 = (p^2 - q^2) \Omega$$

gives

$$D_{p,q}^2 \Omega_1 = 0$$

whence

$$\Omega_1 = P + Q, \quad \Omega = \frac{P + Q}{p^2 - q^2}$$

in which P is an arbitrary function of p , and Q an arbitrary function of q .

This form, therefore, of Ω is the required form of possible integration by quadratures. The integral of the preceding differential equation becomes

$$\begin{aligned} \frac{1}{2} (p^2 - q^2)^2 (p'^2 - q'^2) &= p_1^2 P - q_1^2 Q + H (p^4 - q^4) \\ &\quad + C (p^2 - q^2) \end{aligned}$$

in which C is an arbitrary constant.

If, farther, we denote by P_1^2 or Q_1^2 the following functions of p and q ,

$$P_1^2 = 2H(p^4 - a^4) + 2(P + C)(p^2 - a^2) - B^2$$

$$Q_1^2 = 2H(q^4 - a^4) + 2(Q - C)(q^2 - a^2) - B^2$$

the combination of the preceding integral with that of living forces gives

$$(p^2 - q^2)p' = P_1, \quad (p^2 - q^2)q' = Q_1$$

These equations give

$$\int_p \frac{1}{P_1} = \int_q \frac{1}{Q_1}, \quad t = \int_p \frac{p^2}{P_1} - \int_q \frac{q^2}{Q_1}$$

$$\varphi = aB \int_p \frac{1}{(p^2 - a^2)P_1} - aB \int_q \frac{1}{(q^2 - a^2)Q_1}$$

It is apparent from the preceding investigation that the complete solution is possible for any value of Ω which is derived by addition or subtraction from any special values for which it is possible.

The integrations are performed by elliptic integrals whenever P and Q have the forms

$$P = A_2 p^2 + A_1 p + A_0 + \frac{A_3}{p - a} + \frac{A_4}{p + a}$$

$$Q = B_2 q^2 + B_1 q + B_0 + \frac{B_3}{a - q} + \frac{B_4}{a + q}$$

and of the coefficients which are thus introduced, A_2 , B_2 , A_0 , and B_0 , can be combined with the constants of the given integrals. When

$$A_2 = -B_2 = -H, \quad \text{and} \quad A_1 = B_1 = 0$$

the integration of the preceding forms is reduced to circular functions.

The forms

$$P = A_1 p, \quad Q = B_1 q$$

correspond to

$$\Omega = \frac{\alpha}{p + q} + \frac{\beta}{p - q}$$

or to the case in which the force emanates from the two fixed points, and follows the law of gravitation.

The case of

$$P = A p^4, \quad Q = -A q^4$$

corresponds to

$$\Omega = A(p^2 + q^2)$$

or to the case in which the force emanates from the point which is midway between the two fixed points, and is proportional to the distance.

The case of

$$P = \frac{A}{p^2 - a^2}, \quad Q = \frac{A}{a^2 - q^2}$$

corresponds to

$$\Omega = \frac{A}{p_1^2 q_1^2} = \frac{A}{a^2 k^2}$$

or to the case in which the force is perpendicular to the fixed axis, and inversely proportional to the cube of the distance from the axis.

FIRST COMET OF 1857.

A RATHER bright Comet was discovered on the 22d of February, by Professor D'ARREST, at Leipsic, who estimated its diameter at 1'.5. The approximate place was

Date.	Leipsic M. T.	α	δ
1857, Feb. 22	16 ^h 40 ^m	320° 37'	+22° 4'

Professor PETERS gives, in the *Astr. Nachr.*, the following observations:—

Date.	Altona M. T.	α	δ
1857, Feb. 25,	17 ^h 11 ^m 12 ^s	21 ^h 32 ^m 17.4 ^s	+24° 24' 26.4"

From these data Mr. PAPE had deduced the following elements:—

Mr. FERGUSON has transmitted the following observation from Washington:—

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$\Delta \alpha$	$\Delta \delta$	α	δ
1857, Mar. 27	8 ^h 15 ^m 17.4 ^s	5	Groombr. 344	+5 ^m 2.66 ^s	+1' 53".29	1 ^h 32 ^m 44.56 ^s	+46° 37' 36".86

Adopted Mean Star-place for 1860.0.

	α	δ
Groombr. 344	1 ^h 27 ^m 54.40 ^s	+46° 36' 34.42"

1857, March 28.

G.

March 14.088, Berlin M. T.

$$\begin{aligned} \pi &= 197^\circ 0.4' \\ \Omega &= 323^\circ 31.7' \\ i &= 87^\circ 6.2' \\ \log q &= 9.82586 \\ &\text{Retrograde.} \end{aligned}$$

This Comet was also detected on the 26th instant by Mr. VAN ARSDALE, at Newark, who sent by telegraph the following approximate place for 8^h 30^m Newark mean time.

$$\alpha = 1^h 21^m; \quad \delta = +46^\circ 42'.$$

Mr. VAN ARSDALE says it is bright, and looks like an unresolved star-cluster.

OBSERVATIONS OF ISIS, ④, MADE AT THE OBSERVATORY OF HARVARD COLLEGE, CAMBRIDGE, U. S.

1856, Aug. 14th, 9^h 24^m 58^s Camb. m. s. t. *Isis* precedes (a) by 1^m 39^s.02, 6 obs., and is north of it 2' 32".0, 3 obs. (a) is Arg. Zone 209.98. The planet is as bright as a star of the 11th magnitude.

1856, Sept. 25, 7^h 47^m 55^s Camb. m. s. t. *Isis* follows (b) by 0^m 1^s.66, 4 obs., and is north of it 1' 0".5, 4 obs. (b) is Arg. Zone, 306.14. The planet resembles a star of the 12th - 13th magnitude.

1856, Nov. 15th, 6^h 7^m 16^s Camb. m. s. t. *Isis* follows (c) by 0^m 50^s.77, 13 obs., and is north of it 6' 24".0, 8 obs. (c) is Arg. Zone 231.11, and 241.11. Owing to its faintness, the planet is observed with difficulty.

1856, Dec. 18, 6^h 0^m 3^s Camb. m. s. t. *Isis* follows (d) by 0^m 30^s.54, 12 obs., and is south of it 5' 58".1, 3 obs. (d) is Arg. Zone 234.3. The planet is extremely difficult to observe from its faintness.

The places of the star (d), which has been observed by LACAILLE, LALANDE, ARGELANDER, and WROTTSLEY, differ by several seconds in right ascension. The declinations are also discordant.

The following position, kindly communicated by Lieut. MAURY, Director of the National Observatory, is an accurate determination from two observations in 1853.

A. R. 20^h 31^m 37^s.07 Mean Eq. 1856.0.
Dec. -24° 17' 48".8 " " "

A comparison of the right ascensions of this star by different authorities shows a sensible proper motion of about +0^s.03. The declinations require a proper motion of +0".3, but the remaining discrepancies are still large.

Original Positions uncorrected for Proper Motion.

Authority.	A. R. of (d). Mean Eq. 1856.0.	Dec of (d) Mean Eq. 1856.0.
Lacaille, 1750,	20 31 32.96	-24 18 8.3
Lalande, 1795,	20 31 35.52	24 18 14.0
Argelander, 1849,	20 31 36.64	24 17 45.8
Wrottsley, 1850.7,	20 31 36.93	
Washington Obs., 1853.6,	20 31 37.07	-24 17 48.8

W. C. BOND, Director of H. C. Observatory.

CORRIGENDA IN VOL. IV.

Page 177, col. 2, line 6, for increasing, read decreasing.

" " " " " 12, " $m = 0$ " $m = \infty$.

" " " " " 17, " $(n-3)n-5$ " $(n-3)(n-5)$.

" 178, line 13, 2d denominator, for $2p \cos \varphi$, read $8p \cos \varphi$.

" " col. 1, line 14, make second term of equation negative.

" 179, " 2, " 14, for $\cos^{\frac{3}{2}}$ read $\cos^{\frac{n}{2}}$.

" " " 2, " 22, " $\sin^2 \varphi$, " $\sin \varphi$.

" 180, " 2, " 19, " dx^2 " dy^2 .

" " line -12, for $\sqrt{y} u_{n-1}$ " $\sqrt{y} u_{n+1}$.

Page 180, line -1, for $5y^3$ read cy^3 .

" 181, line 3, for $\frac{1}{3} \{ (4n^3 + 2yn^2, \text{read } \frac{1}{8} \{ (4n^3 + 27n^2$.

" " " " " -34, " -84.

" 182, col. 1, line 13, for $r^{\frac{n-1}{2}}$ read $3r^{\frac{n-1}{2}}$.

" " line 17, for $\frac{\gamma}{\cos \phi} + \frac{1}{4 \cos \phi^2}$ read $\frac{\gamma}{\cos^2 \phi} + \frac{1}{(4 \cos \phi)^2}$.

In the numerical computation, 3 is repeatedly printed for 8.

In the Index, under BRÜNNOW,

for On an error in his tables, read On the error of his tables.

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OBSERVATIONS OF ISIS, ④, MADE AT THE OBSERVATORY OF HARVARD COLLEGE, BY W. C. BOND, ESQ.

CORRIGENDA IN VOL. IV.

THE ASTRONOMICAL JOURNAL.

No. 102.

VOL. V.

ALBANY, 1857, APRIL 22.

NO. 6.

FROM A LETTER OF DR. C. BRUHNS TO THE EDITOR.

Berlin, 1857, March 20.

TO-DAY I write to inform you of my detection of a new comet, which I found the evening before last at 8^h, and recognized as one yesterday by its motion. Dr. FORSTER and I observed it:—

	Berlin M. T.	α	δ
	h m s		
March 18	8 28 30.6	30° 49' 51.3	+8° 19' 30.0
19	7 40 43.2	31 39 53.2	+9 17 23.2

It has no tail, but appears as a small round nebula of 2' diameter and condensed nucleus,—and is easy of observation.

C. BRUHNS.

ON THE ORBIT OF MELPOMENE, AND ITS EPHEMERIS FOR 1858.

By ERNEST SCHUBERT.

[Report to Professor WINLOCK, Superintendent American Ephemeris.]

I. THE elements of *Melpomene* published in No. 94 of the *Astronomical Journal* were derived by the method of least squares from six normal places. The interval of time between the first and the last of those normals being only about three years, and therefore not yet comprising a whole revolution, and the normal place 1853, October 26, being evidently not very accurate (derived from only a few uncertain observations), I concluded to undertake once more the correction of the elements. For that purpose an additional normal place was formed from observations in 1856, and that of 1853, October 26, omitted; then, in order to have everything as accurate as possible, the perturbations by *Jupiter* and *Saturn* were computed anew, with the above-mentioned elements,

from 1852, May 30, up to the end of 1856. Those elements, now finally to be corrected, are:—

1854, Jan. 0, M. T. Berlin.

M	79° 52' 42.9	} m. eq. ep.
π	15 14 13.6	
Ω	150 1 5.2	
i	10 9 4.8	
φ	12 32 46.1	
μ	1019.97998	
$\log \mu$	3.0085917	
$\log a$	0.3609433	

NORMAL PLACES REFERRED TO THE MEAN EQUINOX 1854, JAN. 0.

		α	δ
1852, July 1.0	M. T. Berlin,	271° 35' 16.53 from 17 obs.	— 8° 35' 16.00 from 16 obs.
" Oct. 1.0	"	274 56 46.92 " 19 "	—18 24 28.78 " 17 "
1853, Jan. 1.0	"	322 28 46.75 " 9 "	—16 2 17.53 " 10 "
1854, " 28.0	"	128 3 16.18 " 15 "	+12 2 48.34 " 16 "
1855, April 26.0	"	223 23 31.65 " 14 "	— 0 58 16.38 " 14 "
1856, Oct. 22.0	"	39 13 48.02 " 20 "	— 5 12 59.07 " 16 "

Perturbations of the Co-ordinates by Jupiter and Saturn for the Dates of the Normals in Units of the 7th Decimal, counted from 1854, Jan. 0. (Fundamental plane is the equator.)

$x - x^{\circ}$	$y - y^{\circ}$	$z - z^{\circ}$	$x - x^{\circ}$	$y - y^{\circ}$	$z - z^{\circ}$
+4823	+3296	+ 592	+ 2	+ 19	+ 8
+4757	+3854	+ 944	- 405	+ 4563	+ 1885
+2785	+3858	+1159	-41657	+49148	+16513

With the differences (c. — o.) and new differential coefficients, we have the following equations of condition in which 100 $d\mu$ is introduced: —

$0 = - 0.02$	$+1.72507 dM$	$-3.46371 d\varphi$	$+1.76341 d\pi$	$-0.01327 d\Omega$	$+0.11791 di$	$- 9.60585 d\mu$
$0 = - 2.11$	$+1.05428$	-2.12179	$+0.96271$	-0.00356	$+0.03244$	$- 5.53250$
$0 = + 2.18$	$+0.98888$	-1.13494	$+0.69111$	-0.02955	$+0.01693$	$- 3.91254$
$0 = + 3.92$	$+1.54040$	$+3.09070$	$+1.69341$	-0.05026	-0.05610	$+ 0.38965$
$0 = + 0.85$	$+1.05335$	-1.21848	$+1.51267$	-0.01736	$+0.35622$	$+ 5.19856$
$0 = +73.74$	$+3.21295$	$+1.63979$	$+2.06075$	-0.07675	$+0.47456$	$+33.30130$
$0 = - 1.00$	$-0.08528 dM$	$+0.22198 d\varphi$	$-0.13034 d\pi$	$+0.17877 d\Omega$	$+1.44227 di$	$+ 0.73639 d\mu$
$0 = - 4.00$	$+0.12241$	$+0.18470$	-0.09555	$+0.17529$	$+0.48963$	$+ 0.52905$
$0 = - 0.09$	$+0.12166$	-0.18671	$+0.08963$	$+0.12531$	-0.11444	$- 0.53821$
$0 = - 2.74$	-0.11837	-0.24087	-0.14720	-0.27302	-0.64995	$- 0.13495$
$0 = - 0.02$	-0.25846	$+0.20020$	-0.38766	-0.08737	$+1.41267$	$- 1.07558$
$0 = +19.07$	$+0.92431$	-0.01619	$+0.57207$	$+0.16001$	-1.80113	$+ 9.04078$

These furnish the six final equations: —

$0 = + 261.962$	$+19.8431 dM$	$- 0.6909 d\varphi$	$+16.2435 d\pi$	$-0.2484 d\Omega$	$-0.0820 di$	$+ 95.2554 d\mu$
$0 = + 132.976$	$- 0.6909$	$+31.7304$	$- 2.2797$	-0.0421	$+0.5748$	$+ 98.9615$
$0 = + 170.811$	$+16.2435$	$- 2.2797$	$+14.4499$	-0.2254	-0.0547	$+ 57.5942$
$0 = - 3.0397$	$- 0.2484$	$- 0.0421$	$- 0.2254$	$+0.1979$	$+0.0425$	$- 0.8246$
$0 = - 0.9450$	$- 0.0820$	$+ 0.5748$	$- 0.0547$	$+0.0425$	$+8.3657$	$- 0.0768$
$0 = +2635.003$	$+95.2554$	$+98.9615$	$+57.5942$	-0.8246	-0.0768	$+1358.3650$

These final equations give

$$\begin{aligned} dM &= -22''.33 \\ d\varphi &= + 0.19 \\ d\pi &= +17.92 \\ d\Omega &= + 3.01 \\ di &= - 0.03 \\ d\mu &= - 0.011460 \end{aligned}$$

These corrections are so small, that any farther correction of the elements will be impossible for a long time, and we may now consider our knowledge of the orbit of *Melpomene* as perfect.

Twice corrected elements: —

1854, Jan. 0, Berlin M. T.

M	$79^{\circ} 52' 20''.57$	} m. eq. ep.
π	$15 14 31.52$	
Ω	$150 1 8.21$	
i	$10 9 4.77$	
φ	$1019''.96852$	
$\log \mu$	3.0085868	
$\log a$	0.3609465	

The correctness of the whole is proved by the residuals after the substitution of the corrections in the equations of condition, and after the computation of the normals from the corrected elements: —

$\Delta \alpha \cos \delta$		$\Delta \delta$	
Subst.	Comp.	Subst.	Comp.
$+3''.38$	$+3''.49$	$-1''.74$	$-1''.78$
-2.50	-2.43	-3.04	-3.07
-3.33	-3.22	-0.24	-0.21
-0.13	-0.08	-3.43	-3.44
-1.88	-1.96	-0.23	-0.24
$+0.84$	$+0.70$	-1.15	-1.14

II. Next the computation of the perturbations was carried on up to the middle of 1858. In 1857, *Melpomene* was not in opposition; therefore I have computed an ephemeris for the opposition in 1858, for the Berlin meridian, not having received yet a copy of the American *Nautical Almanac* with the co-ordinates of the sun for the Washington meridian.

The ephemeris itself you will receive herewith, and also a new table of the perturbations.

TABLE OF INTEGRATION. (Second Computation.)

Washington Mean Noon.

Date.	$t - 1854.0$	ξ	η	ζ	Date.	$t - 1854.0$	ξ	η	ζ
1852, May 30	-580	+4402.2	+3257.8	+ 510.4	1855, Aug. 3	+ 580	+ 501.9	+ 6666.9	+ 2429.8
July 9	540	4948.6	3310.4	616.4	Sept. 12	620	1269.2	7999.8	2706.6
Aug. 18	500	5107.8	3543.0	763.1	Oct. 22	660	2271.0	9852.4	3075.1
Sept. 27	460	4838.2	3837.4	930.2	Dec. 1	700	3423.1	12461.3	3602.8
Nov. 6	420	4163.4	4037.3	1078.9	1856, Jan. 10	740	4510.3	16103.9	4380.8
Dec. 16	380	3199.9	3992.7	1162.2	Feb. 19	780	5114.2	21045.3	5517.4
1853, Jan. 25	340	2150.2	3623.7	1143.1	March 30	820	4545.8	27413.6	7112.9
March 6	300	1237.2	2975.0	1016.4	May 9	860	+ 1851.1	34973.9	9201.1
April 15	260	603.8	2201.6	815.0	June 18	900	- 3988.2	42845.5	11658.2
May 25	220	256.2	1478.0	591.3	July 28	940	13529.8	49346.6	14113.2
July 4	180	104.2	907.5	388.7	Sept. 6	980	26190.2	52354.1	15975.9
Aug. 13	140	47.6	505.5	227.9	Oct. 16	1020	39938.7	50299.9	16659.9
Sept. 22	100	23.2	241.0	112.1	Nov. 25	1060	52050.1	43152.3	15906.8
Nov. 1	60	8.3	80.3	37.8	1857, Jan. 4	1100	60372.1	32437.8	13910.1
Dec. 11	- 20	0.2	3.2	1.5	Feb. 13	1140	64104.5	20325.2	11151.5
1854, Jan. 20	+ 20	0.3	3.2	1.5	March 23	1180	63648.4	+ 8680.4	8143.8
March 1	60	6.1	80.6	37.4	May 4	1220	60013.8	- 1354.5	5268.1
April 10	100	10.9	236.8	108.7	June 13	1260	54308.1	9307.2	2741.3
May 20	140	+ 5.9	470.6	214.2	July 23	1300	47466.5	15158.4	+ 648.2
June 29	180	- 17.6	777.3	351.4	Sept. 1	1340	40172.9	19130.0	- 1011.1
Aug. 8	220	65.7	1148.9	516.5	Oct. 11	1380	32876.7	21538.3	2281.1
Sept. 17	260	140.0	1574.8	704.4	Nov. 20	1420	25841.9	22708.9	3225.1
Oct. 27	300	235.6	2043.5	909.2	Dec. 31	1460	19198.3	22934.2	3909.1
Dec. 6	340	341.0	2545.0	1124.4	1858, Feb. 8	1500	12983.2	22455.4	4393.5
1855, Jan. 15	380	436.2	3072.9	1343.8	March 20	1540	7174.7	21457.1	4728.6
Feb. 24	420	492.4	3628.0	1562.1	April 29	1580	- 1715.3	20068.2	4952.9
April 5	460	472.4	4222.6	1776.1	June 8	1620	+ 3470.1	18365.3	5091.9
May 15	500	331.8	4886.1	1986.2	July 18	+1660	+ 8460.4	-16375.3	- 5158.3
June 24	+540	- 22.0	+5672.0	+2199.0					

EPHEMERIS OF MELPOMENE FOR THE OPPOSITION IN 1858.

Mean Time Berlin.

Date.	α	δ	Log Δ	Log r	Date.	α	δ	Log Δ	Log r
Feb. 17	12 ^h 30 ^m 54.00 ^s	+3 [°] 4' 3.6"	0.276088	0.437893	March 9	12 ^h 17 ^m 43.45 ^s	+5 [°] 56' 48.7"	0.251728	0.440587
18	30 26.36	3 11 42.8	0.274359		10	16 53.34	6 6 3.5	0.251163	
19	29 57.29	3 19 30.2	0.272676	0.438186	11	16 2.57	6 15 18.2	0.250668	0.440827
20	29 26.82	3 27 25.7	0.271040		12	15 11.19	6 24 32.4	0.250244	
21	28 54.97	3 35 28.9	0.269453	0.438473	13	14 19.25	6 33 45.0	0.249892	0.441063
22	28 21.77	3 43 39.5	0.267914		14	13 26.82	6 42 56.4	0.249611	
23	27 47.24	3 51 57.2	0.266426	0.438755	15	12 33.95	6 52 5.2	0.249403	0.441293
24	27 11.42	4 0 21.6	0.264991		16	11 40.71	7 1 11.4	0.249267	
25	26 34.33	4 8 52.4	0.263610	0.439033	17	10 47.17	7 10 14.3	0.249204	0.441519
26	25 56.01	4 17 29.0	0.262285		18	9 53.38	7 19 13.4	0.249214	
27	25 16.48	4 26 11.4	0.261017	0.439305	19	8 59.41	7 28 8.2	0.249295	0.441739
28	24 35.79	4 34 59.0	0.259807		20	8 5.32	7 36 58.2	0.249449	
March 1	23 53.96	4 43 51.3	0.258657	0.439572	21	7 11.17	7 45 42.8	0.249674	0.441953
2	23 11.03	4 52 47.8	0.257567		22	6 17.03	7 54 21.6	0.249971	
3	22 27.05	5 1 48.3	0.256538	0.439833	23	5 22.96	8 2 54.0	0.250339	0.442162
4	21 42.05	5 10 52.4	0.255572		24	4 29.01	8 11 19.7	0.250778	
5	20 56.09	5 19 59.3	0.254670	0.440090	25	3 35.25	8 19 38.2	0.251287	0.442366
6	20 9.20	5 29 9.0	0.253834		26	2 41.75	8 27 49.2	0.251866	
7	19 21.43	5 38 20.9	0.253064	0.440341	27	1 48.55	8 35 52.2	0.252515	0.442565
8	12 18 32.83	+5 47 34.3	0.252362		28	12 0 55.71	+8 43 46.9	0.253232	

♂ 1858, March 19, 11^h 50^m 44^s.2, M. T. Berlin. Intensity of light = 0.367.

Date.	α	δ	Log Δ	Log r	Date.	α	δ	Log Δ	Log r
March 29	12 ^h 0 ^m 3.29 ^s	+ 8 ^o 51' 32.8"	0.254016	0.442759	April 15	11 ^h 47 ^m 4.79 ^s	+10 ^o 36' 35.7"	0.276604	
30	11 59 11.33	8 59 9.7	0.254867		16	46 28.16	10 40 59.2	0.278401	0.444273
31	58 19.90	9 6 37.1	0.255783	0.442948	17	45 52.77	10 45 10.0	0.280241	
April 1	57 29.05	9 13 54.8	0.256764		18	45 18.66	10 49 8.0	0.282122	0.444415
2	56 38.82	9 21 2.4	0.257808	0.443131	19	44 45.85	10 52 53.4	0.284041	
3	55 49.28	9 27 59.7	0.258915		20	44 14.37	10 56 26.0	0.285998	0.444552
4	55 0.46	9 34 46.4	0.260083	0.443310	21	43 44.22	10 59 46.0	0.287991	
5	54 12.42	9 41 22.3	0.261311		22	43 15.42	11 2 53.1	0.290018	0.444683
6	53 25.21	9 47 47.0	0.262597	0.443484	23	42 47.99	11 5 47.6	0.292079	
7	52 38.87	9 54 0.4	0.263941		24	42 21.94	11 8 29.5	0.294171	0.444810
8	51 53.46	10 0 2.2	0.265342	0.443652	25	41 57.28	11 10 59.1	0.296293	
9	51 9.01	10 5 52.2	0.266797		26	41 34.02	11 13 16.3	0.298443	0.444933
10	50 25.57	10 11 30.2	0.268306	0.443814	27	41 12.16	11 15 21.3	0.300619	
11	49 43.17	10 16 56.1	0.269868		28	40 51.71	11 17 14.0	0.302821	0.445049
12	49 1.86	10 22 9.7	0.271480	0.443972	29	40 32.67	11 18 54.6	0.305046	
13	48 21.67	10 27 10.9	0.273141		30	11 40 15.05	+11 20 23.1	0.307292	0.445160
14	11 47 42.64	+10 31 59.6	0.274850	0.444126					

r is the undisturbed radius-vector in the ellipse 1854.0.

TABLES FOR INTERPOLATING FROM GREENWICH TO WASHINGTON MEAN NOON, AND THE REVERSE.

By GEORGE EASTWOOD,

ASSISTANT IN THE OFFICE OF THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC.

THE accompanying Table contains the values of $A\Delta'$, $B\Delta''$, $C\Delta'''$, $D\Delta^{IV}$, used in converting the values of any function, u , computed for Greenwich mean time, into its value for the corresponding time at Washington; or conversely from Washington to Greenwich time. A is $\frac{1}{24}$ ($5^h 8^m 12^s$), and B , C , D , are the well-known functions of A . For Greenwich differences, $A\Delta$ is to be taken with the same sign as Δ ; for Washington differences, with the contrary sign.

The first Table gives values of $A\Delta$ for argument Δ , the second gives $B\Delta''$, $C\Delta'''$, or $D\Delta^{IV}$, for Δ'' , Δ''' , or Δ^{IV} , used as arguments respectively.

TABLE I.

Δ	$A\Delta$	Δ	$A\Delta$	Δ	$A\Delta$	Δ	$A\Delta$	Δ	$A\Delta$	Δ	$A\Delta$	Δ	$A\Delta$	Δ	$A\Delta$	Δ	$A\Delta$	Δ	$A\Delta$
1	0	19	4	37	8	55	12	73	16	91	19	1000	214	2800	599	4600	984	6400	1370
2	0	20	4	38	8	56	12	74	16	92	20	1100	235	2900	621	4700	1006	6500	1391
3	1	21	4	39	8	57	12	75	16	93	20	1200	257	3000	642	4800	1027	6600	1412
4	1	22	5	40	9	58	12	76	16	94	20	1300	278	3100	663	4900	1049	6700	1434
5	1	23	5	41	9	59	12	77	16	95	20	1400	300	3200	685	5000	1070	6800	1455
6	1	24	5	42	9	60	13	78	17	96	21	1500	321	3300	706	5100	1091	6900	1477
7	1	25	5	43	9	61	13	79	17	97	21	1600	342	3400	728	5200	1113	7000	1498
8	2	26	6	44	9	62	13	80	17	98	21	1700	364	3500	749	5300	1131	7100	1519
9	2	27	6	45	10	63	13	81	17	99	21	1800	385	3600	770	5400	1156	7200	1541
10	2	28	6	46	10	64	13	82	18	100	21	1900	407	3700	792	5500	1177	7300	1562
11	2	29	6	47	10	65	14	83	18	200	43	2000	428	3800	813	5600	1198	7400	1584
12	3	30	6	48	10	66	14	84	18	300	64	2100	449	3900	835	5700	1220	7500	1605
13	3	31	7	49	10	67	14	85	18	400	86	2200	471	4000	856	5800	1241	7600	1626
14	3	32	7	50	11	68	15	86	18	500	107	2300	492	4100	877	5900	1263	7700	1648
15	3	33	7	51	11	69	15	87	19	600	128	2400	514	4200	899	6000	1284	7800	1669
16	3	34	7	52	11	70	15	88	19	700	150	2500	535	4300	920	6100	1305	7900	1691
17	4	35	7	53	11	71	15	89	19	800	171	2600	556	4400	942	6200	1327	8000	1712
18	4	36	8	54	12	72	15	90	19	900	193	2700	578	4500	963	6300	1348	8100	1733

Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$
10000	2140	16200	3467	22400	4794	28600	6121	34800	7448	41000	8775	47200	10102	53400	11429
10100	2161	16300	3488	22500	4815	28700	6143	34900	7470	41100	8796	47300	10123	53500	11450
10200	2183	16400	3510	22600	4836	28800	6164	35000	7491	41200	8818	47400	10145	53600	11471
10300	2204	16500	3531	22700	4858	28900	6186	35100	7512	41300	8839	47500	10166	53700	11493
10400	2226	16600	3552	22800	4879	29000	6207	35200	7534	41400	8861	47600	10187	53800	11514
10500	2247	16700	3574	22900	4901	29100	6228	35300	7555	41500	8882	47700	10209	53900	11536
10600	2268	16800	3595	23000	4922	29200	6250	35400	7577	41600	8903	47800	10230	54000	11557
10700	2290	16900	3617	23100	4943	29300	6271	35500	7598	41700	8925	47900	10252	54100	11578
10800	2311	17000	3638	23200	4965	29400	6293	35600	7619	41800	8946	48000	10273	54200	11600
10900	2333	17100	3659	23300	4986	29500	6314	35700	7641	41900	8968	48100	10294	54300	11621
11000	2354	17200	3681	23400	5008	29600	6335	35800	7662	42000	8989	48200	10316	54400	11643
11100	2375	17300	3702	23500	5029	29700	6357	35900	7684	42100	9010	48300	10337	54500	11664
11200	2397	17400	3724	23600	5050	29800	6378	36000	7705	42200	9032	48400	10359	54600	11685
11300	2418	17500	3745	23700	5072	29900	6400	36100	7726	42300	9053	48500	10380	54700	11707
11400	2440	17600	3766	23800	5093	30000	6421	36200	7748	42400	9075	48600	10401	54800	11728
11500	2461	17700	3788	23900	5115	30100	6442	36300	7769	42500	9096	48700	10423	54900	11750
11600	2482	17800	3809	24000	5136	30200	6464	36400	7791	42600	9117	48800	10444	55000	11771
11700	2504	17900	3831	24100	5157	30300	6485	36500	7812	42700	9139	48900	10466	55100	11792
11800	2525	18000	3852	24200	5179	30400	6507	36600	7833	42800	9160	49000	10487	55200	11814
11900	2547	18100	3873	24300	5200	30500	6528	36700	7855	42900	9182	49100	10508	55300	11835
12000	2568	18200	3895	24400	5222	30600	6549	36800	7876	43000	9203	49200	10530	55400	11857
12100	2589	18300	3916	24500	5243	30700	6571	36900	7898	43100	9224	49300	10551	55500	11878
12200	2611	18400	3937	24600	5264	30800	6592	37000	7919	43200	9246	49400	10573	55600	11899
12300	2632	18500	3959	24700	5286	30900	6614	37100	7940	43300	9267	49500	10594	55700	11921
12400	2654	18600	3980	24800	5307	31000	6635	37200	7962	43400	9289	49600	10615	55800	11942
12500	2675	18700	4001	24900	5329	31100	6656	37300	7983	43500	9310	49700	10637	55900	11964
12600	2696	18800	4023	25000	5350	31200	6678	37400	8005	43600	9331	49800	10658	56000	11985
12700	2718	18900	4045	25100	5371	31300	6699	37500	8026	43700	9353	49900	10680	56100	12006
12800	2739	19000	4066	25200	5393	31400	6721	37600	8047	43800	9374	50000	10701	56200	12028
12900	2761	19100	4087	25300	5414	31500	6742	37700	8069	43900	9396	50100	10722	56300	12049
13000	2782	19200	4109	25400	5436	31600	6763	37800	8090	44000	9417	50200	10744	56400	12071
13100	2803	19300	4130	25500	5457	31700	6785	37900	8112	44100	9438	50300	10765	56500	12092
13200	2825	19400	4152	25600	5478	31800	6806	38000	8133	44200	9460	50400	10787	56600	12113
13300	2846	19500	4173	25700	5500	31900	6828	38100	8154	44300	9481	50500	10808	56700	12135
13400	2868	19600	4194	25800	5521	32000	6849	38200	8176	44400	9503	50600	10829	56800	12156
13500	2889	19700	4216	25900	5543	32100	6870	38300	8197	44500	9524	50700	10851	56900	12178
13600	2910	19800	4237	26000	5564	32200	6892	38400	8219	44600	9545	50800	10872	57000	12199
13700	2932	19900	4259	26100	5586	32300	6913	38500	8240	44700	9567	50900	10894	57100	12221
13800	2953	20000	4280	26200	5608	32400	6935	38600	8261	44800	9588	51000	10915	57200	12243
13900	2975	20100	4301	26300	5629	32500	6956	38700	8283	44900	9610	51100	10936	57300	12264
14000	2996	20200	4323	26400	5651	32600	6977	38800	8304	45000	9631	51200	10958	57400	12286
14100	3017	20300	4344	26500	5672	32700	6999	38900	8326	45100	9652	51300	10979	57500	12307
14200	3039	20400	4366	26600	5693	32800	7020	39000	8347	45200	9674	51400	11001	57600	12328
14300	3060	20500	4387	26700	5715	32900	7042	39100	8368	45300	9695	51500	11022	57700	12350
14400	3082	20600	4408	26800	5736	33000	7063	39200	8390	45400	9717	51600	11043	57800	12371
14500	3103	20700	4430	26900	5758	33100	7084	39300	8411	45500	9738	51700	11065	57900	12393
14600	3125	20800	4451	27000	5779	33200	7106	39400	8433	45600	9759	51800	11086	58000	12414
14700	3146	20900	4473	27100	5800	33300	7127	39500	8454	45700	9781	51900	11108	58100	12435
14800	3167	21000	4494	27200	5822	33400	7149	39600	8475	45800	9803	52000	11129	58200	12457
14900	3189	21100	4515	27300	5843	33500	7170	39700	8497	45900	9825	52100	11150	58300	12478
15000	3210	21200	4537	27400	5865	33600	7191	39800	8518	46000	9846	52200	11172	58400	12500
15100	3231	21300	4558	27500	5886	33700	7213	39900	8540	46100	9867	52300	11193	58500	12521
15200	3253	21400	4580	27600	5907	33800	7234	40000	8561	46200	9888	52400	11215	58600	12542
15300	3274	21500	4501	27700	5929	33900	7256	40100	8582	46300	9909	52500	11236	58700	12564
15400	3296	21600	4622	27800	5950	34000	7277	40200	8604	46400	9931	52600	11257	58800	12585
15500	3317	21700	4644	27900	5972	34100	7298	40300	8625	46500	9952	52700	11279	58900	12607
15600	3338	21800	4665	28000	5993	34200	7320	40400	8647	46600	9973	52800	11300	59000	12628
15700	3360	21900	4687	28100	6014	34300	7341	40500	8668	46700	9995	52900	11322	59100	12649
15800	3381	22000	4708	28200	6036	34400	7363	40600	8689	46800	10016	53000	11343	59200	12671
15900	3403	22100	4729	28300	6057	34500	7384	40700	8711	46900	10038	53100	11364	59300	12692
16000	3424	22200	4751	28400	6079	34600	7405	40800	8732	47000	10059	53200	11386	59400	12714
16100	3445	22300	4772	28500	6100	34700	7427	40900	8754	47100	10080	53300	11407	59500	12735

Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$	Δ	$\Delta\Delta$
59600	12756	65400	13998	71200	15239	77000	16480	82800	17721	88600	18962	94400	20205
59700	12778	65500	14019	71300	15260	77100	16501	82900	17743	88700	18984	94500	20226
59800	12799	65600	14040	71400	15282	77200	16523	83000	17764	88800	19005	94600	20247
59900	12821	65700	14062	71500	15303	77300	16544	83100	17785	88900	19027	94700	20269
60000	12842	65800	14083	71600	15324	77400	16566	83200	17807	89000	19048	94800	20290
60100	12863	65900	14105	71700	15346	77500	16587	83300	17828	89100	19069	94900	20312
60200	12885	66000	14126	71800	15367	77600	16608	83400	17850	89200	19091	95000	20333
60300	12906	66100	14147	71900	15389	77700	16630	83500	17871	89300	19112	95100	20354
60400	12928	66200	14169	72000	15410	77800	16651	83600	17892	89400	19133	95200	20376
60500	12949	66300	14190	72100	15431	77900	16673	83700	17914	89500	19155	95300	20397
60600	12970	66400	14212	72200	15453	78000	16694	83800	17935	89600	19176	95400	20419
60700	12992	66500	14233	72300	15474	78100	16715	83900	17957	89700	19198	95500	20440
60800	13013	66600	14254	72400	15496	78200	16737	84000	17978	89800	19219	95600	20461
60900	13035	66700	14276	72500	15517	78300	16758	84100	17999	89900	19241	95700	20483
61000	13056	66800	14297	72600	15536	78400	16780	84200	18021	90000	19262	95800	20504
61100	13077	66900	14319	72700	15560	78500	16801	84300	18042	90100	19285	95900	20526
61200	13099	67000	14340	72800	15581	78600	16822	84400	18064	90200	19306	96000	20547
61300	13120	67100	14361	72900	15603	78700	16844	84500	18085	90300	19327	96100	20568
61400	13142	67200	14383	73000	15624	78800	16865	84600	18106	90400	19349	96200	20590
61500	13163	67300	14404	73100	15645	78900	16887	84700	18128	90500	19370	96300	20611
61600	13184	67400	14426	73200	15667	79000	16908	84800	18149	90600	19391	96400	20633
61700	13206	67500	14447	73300	15688	79100	16929	84900	18171	90700	19413	96500	20654
61800	13227	67600	14468	73400	15710	79200	16951	85000	18192	90800	19434	96600	20675
61900	13249	67700	14490	73500	15731	79300	16972	85100	18213	90900	19456	96700	20697
62000	13270	67800	14511	73600	15752	79400	16994	85200	18235	91000	19477	96800	20718
62100	13291	67900	14533	73700	15774	79500	17015	85300	18256	91100	19498	96900	20740
62200	13313	68000	14554	73800	15795	79600	17036	85400	18278	91200	19520	97000	20761
62300	13334	68100	14575	73900	15817	79700	17058	85500	18299	91300	19541	97100	20783
62400	13356	68200	14597	74000	15838	79800	17079	85600	18320	91400	19563	97200	20804
62500	13377	68300	14618	74100	15859	79900	17101	85700	18342	91500	19584	97300	20825
62600	13398	68400	14640	74200	15881	80000	17122	85800	18363	91600	19605	97400	20847
62700	13420	68500	14661	74300	15902	80100	17143	85900	18385	91700	19627	97500	20868
62800	13441	68600	14682	74400	15924	80200	17165	86000	18406	91800	19648	97600	20889
62900	13463	68700	14704	74500	15945	80300	17186	86100	18427	91900	19670	97700	20911
63000	13484	68800	14725	74600	15966	80400	17208	86200	18449	92000	19691	97800	20932
63100	13505	68900	14747	74700	15988	80500	17229	86300	18470	92100	19712	97900	20954
63200	13527	69000	14768	74800	16009	80600	17250	86400	18492	92200	19734	98000	20975
63300	13548	69100	14789	74900	16031	80700	17272	86500	18513	92300	19755	98100	20996
63400	13570	69200	14811	75000	16052	80800	17293	86600	18534	92400	19777	98200	21018
63500	13591	69300	14832	75100	16073	80900	17315	86700	18556	92500	19798	98300	21039
63600	13612	69400	14854	75200	16095	81000	17336	86800	18577	92600	19819	98400	21061
63700	13634	69500	14875	75300	16116	81100	17357	86900	18599	92700	19841	98500	21082
63800	13655	69600	14896	75400	16138	81200	17379	87000	18620	92800	19862	98600	21103
63900	13677	69700	14918	75500	16159	81300	17400	87100	18641	92900	19884	98700	21125
64000	13698	69800	14939	75600	16180	81400	17422	87200	18663	93000	19905	98800	21146
64100	13719	69900	14961	75700	16202	81500	17443	87300	18684	93100	19926	98900	21168
64200	13741	70000	14982	75800	16223	81600	17464	87400	18706	93200	19948	99000	21189
64300	13762	70100	15003	75900	16245	81700	17486	87500	18727	93300	19969	99100	21210
64400	13784	70200	15025	76000	16266	81800	17507	87600	18748	93400	19991	99200	21232
64500	13805	70300	15046	76100	16287	81900	17529	87700	18770	93500	20012	99300	21253
64600	13826	70400	15068	76200	16309	82000	17550	87800	18791	93600	20033	99400	21275
64700	13848	70500	15089	76300	16330	82100	17571	87900	18813	93700	20055	99500	21296
64800	13869	70600	15110	76400	16352	82200	17593	88000	18834	93800	20076	99600	21317
64900	13891	70700	15132	76500	16373	82300	17614	88100	18855	93900	20098	99700	21339
65000	13912	70800	15153	76600	16394	82400	17636	88200	18877	94000	20119	99800	21360
65100	13933	70900	15175	76700	16416	82500	17657	88300	18898	94100	20140	99900	21382
65200	13955	71000	15196	76800	16437	82600	17678	88400	18920	94200	20162	100000	21403
65300	13976	71100	15217	76900	16459	82700	17700	88500	18941	94300	20183		

TABLE II.

	From Greenwich to Washington.			From Washington to Greenwich.				From Greenwich to Washington.			From Washington to Greenwich.		
	B Δ''	C Δ'''	D Δ^{IV}	B Δ''	C Δ'''	D Δ^{IV}		B Δ''	C Δ'''	D Δ^{IV}	B Δ''	C Δ'''	D Δ^{IV}
± 5	± 0	± 0	± 0	± 1	± 0	± 0	± 65	± 5	± 3	± 2	± 8	± 6	± 5
6	0	0	0	1	1	1	66	6	3	2	9	6	5
7	0	0	0	1	1	1	67	6	3	2	9	6	5
8	1	0	0	1	1	1	68	6	3	2	9	6	5
9	1	0	0	1	1	1	69	6	3	2	9	7	5
10	1	1	0	1	1	1	70	6	4	2	9	7	5
11	1	1	0	1	1	1	71	6	4	2	9	7	5
12	1	1	0	2	1	1	72	6	4	2	9	7	6
13	1	1	0	2	1	1	73	6	4	2	9	7	6
14	1	1	0	2	1	1	74	6	4	2	10	7	6
15	1	1	1	2	1	1	75	6	4	3	10	7	6
16	1	1	1	2	2	1	76	6	4	3	10	7	6
17	1	1	1	2	2	1	77	6	4	3	10	7	6
18	1	1	1	2	2	1	78	6	4	3	10	7	6
19	1	1	1	2	2	1	79	6	4	3	10	8	6
20	2	1	1	3	2	2	80	7	4	3	10	8	6
21	2	1	1	3	2	2	81	7	4	3	10	8	6
22	2	1	1	3	2	2	82	7	4	3	11	8	6
23	2	1	1	3	2	2	83	7	4	3	11	8	6
24	2	1	1	3	2	2	84	7	4	3	11	8	6
25	2	1	1	3	2	2	85	7	4	3	11	8	7
26	2	1	1	3	2	2	86	7	4	3	11	8	7
27	2	1	1	3	3	2	87	7	4	3	11	8	7
28	2	1	1	3	3	2	88	7	4	3	11	8	7
29	2	1	1	4	3	2	89	7	4	3	11	8	7
30	2	2	1	4	3	2	90	8	5	3	12	9	7
31	2	2	1	4	3	2	91	8	5	3	12	9	7
32	2	2	1	4	3	2	92	8	5	3	12	9	7
33	3	2	1	4	3	2	93	8	5	3	12	9	7
34	3	2	1	4	3	2	94	8	5	3	12	9	7
35	3	2	1	5	3	3	95	8	5	3	12	9	7
36	3	2	1	5	3	3	96	8	5	3	12	9	7
37	3	2	1	5	4	3	97	8	5	3	13	9	7
38	3	2	1	5	4	3	98	8	5	3	13	9	8
39	3	2	1	5	4	3	99	8	5	3	13	9	8
40	3	2	1	5	4	3	100	8	5	3	13	10	8
41	3	2	1	5	4	3	200	17	10	7	26	19	15
42	3	2	1	5	4	3	300	25	15	10	39	29	23
43	4	2	1	5	4	3	400	34	20	14	52	38	31
44	4	2	1	6	4	3	500	42	25	17	65	48	39
45	4	2	1	6	4	3	600	50	30	21	78	57	46
46	4	2	2	6	4	4	700	59	35	24	91	67	54
47	4	2	2	6	4	4	800	67	40	28	104	76	62
48	4	2	2	6	5	4	900	76	45	31	117	86	69
49	4	2	2	6	5	4	1000	84	50	35	130	95	77
50	4	3	2	6	5	4	1100	92	55	38	143	105	85
51	4	3	2	7	5	4	1200	101	60	42	156	115	92
52	4	3	2	7	5	4	1300	109	65	45	169	124	100
53	4	3	2	7	5	4	1400	118	70	49	182	134	108
54	4	3	2	7	5	4	1500	126	75	52	195	143	116
55	4	3	2	7	5	4	1600	135	80	56	208	153	123
56	5	3	2	7	5	4	1700	143	85	59	221	162	131
57	5	3	2	7	5	4	1800	151	90	63	234	172	139
58	5	3	2	8	5	4	1900	160	95	66	247	181	146
59	5	3	2	8	6	5	2000	168	100	70	260	191	154
60	5	3	2	8	6	5	2100	177	105	73	273	200	162
61	5	3	2	8	6	5	2200	185	110	77	286	210	169
62	5	3	2	8	6	5	2300	194	115	80	299	219	177
63	5	3	2	8	6	5	2400	202	120	84	312	229	185
64	5	3	2	8	6	5	2500	210	125	87	325	239	193

OBSERVATION OF POLYMNIA.

TO THE EDITOR OF THE ASTRONOMICAL JOURNAL:—

THE extreme faintness of the planet *Polymnia*, during the present opposition, rendering it probable that few observations of it could be made elsewhere, I send you the following, which was obtained by Mr. G. P. BOND, with our twenty-three foot refractor.

POLYMNIA (33). 1857, April 2, 10^h 41^m 40^s Camb. m. s. t.

Planet precedes star *b* by 0^m 2^s.36, 15 comparisons.
Planet south of star *b* by 1' 50".0, 7 "
Star *b* follows star *a* by 1^m 1^s.48, 6 "

Star *b* north of star *a* by 3' 42".1, 3 comparisons.
b is a small star of the 12th magnitude.
a is Weisse, XI. 442 of the 8th magnitude.

The planet was very faint, and difficult to observe, on account of the bright moonlight. It was, however, recognized with certainty by its motion relatively to the stars during the time of observation.

W. C. BOND.

Harvard College Observatory.

SECOND COMET OF 1857.

THE discoverer, Dr. BRUHNS, obtained from the two observations given in his letter, and a third,

	Berlin M. T.	<i>a</i>	<i>δ</i>
March 20	7 ^h 37 ^m 16 ^s .4	32° 31' 35".0	+10° 18' 6".8

the following elements, published by Professor PETERS in the *Astr. Nachr.*, No. 1074.

$T = 1857, \text{ March } 24.9877$
 $\pi = 119^{\circ} 36' 34".3$
 $\Omega = 116^{\circ} 10' 50.4$
 $i = 24^{\circ} 8' 23.5$
 $\log q = 9.759140$

The comet is moving northward, and will be visible during the whole month of May.

In the same number of the *Nachrichten*, Mr. PAPE, of Altona, calls attention to the striking similarity between this comet and the third of 1846, whose return to perihelion had been assigned by Dr. VAN GALEN (*Astr. Nachr.*, No. 926) for 1857, June 28. Putting $T = 1857, \text{ March } 28^{\text{d}}.86$, Berlin m. t., and using the other elements as given for that comet by Dr. VAN GALEN, Mr. PAPE found for the time of the Berlin observations

Date.	$\Delta \lambda$	$\Delta \beta$
March 18	+ 6'	+ 7'
20	-20	+11

This, taken in connection with the indication that these residuals may be greatly diminished by small changes in VAN GALEN's semiaxis and eccentricity, point to the probability of

identity between this comet of BRUHNS and the third of 1846, already predicted for this year.

Dr. C. H. F. PETERS has obtained observations on two nights at the Dudley Observatory, with the ring-micrometer of the Clark comet-seeker, — none of the large instruments having yet been mounted. He writes:—

"The observations of April 17 were obtained with difficulty, on account of the strong wind, which shook the instrument; those of April 18 are good.

1857.	Albany S. T.	<i>a</i>	<i>δ</i>
	^h ^m ^s	^m ^s	
Apr. 17	11 23 52	(a) +2 7.9	(a) -26' 27" 5 comp.
18	10 21 45	(b) +2 12.9	12 "
	10 22 55		(b) + 4 41 10 "

The stars I suppose to be those on Harding's Atlas (1800),

	^h ^m	[°]
(a)	4 1.3	+41 16'
(b)	4 5.8	44 56

both of 8th magnitude.

"The comet has a strong concentration of light in the center, perhaps a stellar nucleus, as might be inferred from the sudden increase of brightness when the center appeared on the edge of the ring. — On the whole, its shape was very much like that of D'ARREST's comet (1857 I.), then about 15° farther south; but it was brighter."

Dr. PETERS adds, that, the region being very rich in stars, he does not feel fully certain as to the correct identification from Harding's Atlas, no other authority being at hand. — This will, however, be soon decided.

G.

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SECOND COMET OF 1857.

THE ASTRONOMICAL JOURNAL.

No. 103.

VOL. V.

ALBANY, 1857, MAY 30.

NO. 7.

PLANET-CIRCULAR.

Cambridge, 1857, May 2.

LETTER FROM MR. JOHNSON TO THE EDITOR.

Radcliffe Observatory, Oxford, 1857, April 16.

I HAVE the pleasure to inform you that another planet, the *forty-third* of the system between *Mars* and *Jupiter*, was discovered last night at this observatory, by Mr. POGSON; the positions of which were as follows:—

	Greenwich M. T.	R. A.	N. P. D.
	^h ^m ^s	^h ^m ^s	[°] ['] ["]
1857, April 15	13 34 14	13 30 19.96	105 43' 2".5
	13 57 12	13 30 18.98	105 42 56.7
	15 24 31	13 30 15.26	105 42 36.3
	Daily motion in R. A.		—61.5 ^s
	" " " N. P. D.		—340"

Magnitude $9\frac{1}{4}$. The new planet is nearly 2° north-preceding the planet *Iris*.

M. J. JOHNSON.

FROM A LETTER OF DR. MOESTA TO LIEUT. GILLISS.

Santiago de Chile, 1857, February 26.

THE corresponding moon-observations kindly sent me by Professor BACHE of the Coast-Survey, have been compared with my observations, and I beg leave to enclose the results.

I have endeavored also to make corresponding observations upon the Zodiacal Light, as requested by the Rev. Mr. JONES, but from November until February very little could be distinguished of this phenomenon here.

Having been requested by Professor PETERS to take part in the distribution of the asteroid observations, I have selected

Egeria, Euphrosyne, Eunomia, and Calliope,

whose southern oppositions I shall endeavor to observe. Meanwhile, I have computed by HANSEN's method the perturbations of *Egeria* by *Jupiter* and *Saturn*, from 1851 up to the end of 1854, and am hoping to finish the work up to 1857, and compute the corresponding ephemeris before the opposition takes place. If I succeed in finishing this work, I will send it to you for publication in the *Astronomical Journal*.

The reductions of my observations as far as 1856 are almost finished, and will be ready for the press in one or two months more.

C. W. MOESTA.

LONGITUDE OF SANTIAGO, DEDUCED FROM CORRESPONDING MOON- CULMINATIONS.

By C. W. MOESTA, Esq.,
DIRECTOR OF THE NATIONAL OBSERVATORY.

Santiago and Cambridge.

Assumed Longitude of Santiago = 4^h 42^m 33^s
 " " " Cambridge = 4^h 44^m 30^s

1st LIMB.				
		Correction. ^s	Weight.	
1852, Oct.	21	—4.430	0.2283	
	22	—4.405	0.2029	
	23	+9.003	0.2401	
	25	—4.511	0.2697	
	26	—4.810	0.2553	
Nov.	20	—7.886	0.1759	
Dec.	22	—5.969	0.3143	
1853, Mar.	19	—3.774	0.3685	
	21	—5.303	0.2744	
	22	—3.586	0.4344	
	23	+3.627	0.3476	
May	17	—1.361	0.3546	
Sept.	12	—1.823	0.4494	
1854, Jan.	9	+3.462	0.3504	
Feb.	9	+2.831	0.4076	
	10	+4.500	0.3330	
	11	+6.774	0.3814	
		—0.64	5.3878	

Santiago and San Francisco (U. S. Coast-Survey Station, Telegraph Hill).

Assumed longitude of Telegraph Hill = 8^h 9^m 34^s.4

1st LIMB.				
		Correction. ^s	Weight.	
1852, Oct.	22	— 5.603	0.1676	
	23	— 1.854	0.1526	
	24	— 5.416	0.1916	
	25	— 4.514	0.1871	
	26	—11.85	0.1896	
Nov.	22	— 5.166	0.1398	
	23	— 2.850	0.1910	
1853, Jan.	19	— 7.526	0.2786	
	20	— 9.319	0.2589	
	22	+ 8.278	0.3091	
		— 4.146	2.0689	
2d LIMB.				
1852, Oct.	29	—14.138	0.1751	
Dec.	26	+ 4.513	0.3481	
1853, Jan.	25	— 2.280	0.2271	
		— 1.806	0.7503	

Santiago and Philadelphia.

Assumed longitude of High School Observatory = 5^h 0^m 38^s

1st LIMB.				
		Correction. ^s	Weight.	
1852, Oct.	23	— 8.015	0.1703	
	26	+ 3.395	0.1837	
1853, May	18	—11.088	0.3829	
	19	+ 6.499	0.3453	
		— 2.533	1.0822	
2d LIMB.				
1852, Sept.	30	—5.278	0.2723	
Oct.	1	—3.288	0.2938	
Nov.	30	—1.271	0.4058	
Dec.	1	—2.842	0.3496	
1853, Jan.	26	+0.782	0.3437	
		—2.188	1.6652	

We then have for the longitude of the Santiago Observatory, deduced from corresponding observations of the moon during the years 1852 – 1856: —

1st LIMB.				
	Correction. ^s	Weight.	No. of Comp.	
Greenwich,	—0.069	19.3249	60	
Hamburg,	+0.254	5.8620	17	
Kremsmünster,	—0.215	3.3180	12	
Cracow,	+4.187	2.8805	10	
Cambridge, Mass.,	—0.64	5.3878	17	
Philadelphia,	—2.533	1.0822	4	
Telegraph Hill,	—4.146	2.0689	10	
	—0.084	38.9243	130	
2d LIMB.				
Greenwich,	—0.576	6.7689	23	
Cracow,	—5.456	0.3161	1	
Philadelphia,	—2.188	1.6652	5	
Telegraph Hill	—1.806	0.7503	3	
	—1.125	9.5005	32	

By both limbs, —0.29 48.4248 162

Assumed longitude, = 4^h 42^m 33^s

Resulting longitude, = 4^h 42^m 32^s.71, with the weight 48.4248, from 162 comparisons.

The values of the longitude of the U. S. Observatory on Santa Lucia, Santiago (now the National Observatory of Chile), as deduced from the observations of the U. S. N. Astronomical Expedition, are as follows: —

162 corresponding culminations of moon's 1st limb,	4 42 33.91
50 " " " " 2d " " " "	33.27
24 occultations of stars, ...	34.16
Lieut GILLISS has adopted, ...	4 42 33.81

OBSERVATIONS OF PSYCHE, FIDES, COMET 1857, I., COMET 1857, II., AND EU-PHROSYNE.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Lieutenant MAURY. — Corrected for refraction.]

P S Y C H E.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	⑬ — *		⑬'s apparent		
				$\Delta \alpha$	$\Delta \delta$	α	δ	
1857, Feb.	15	8 ^h 8 ^m 5.7 ^s	20	B. A. C. 3575	—0 31.11 ^{m s}	— 0 16.43	10 ^h 19 ^m 36.27 ^s	+10 ^o 29' 2.13"
	17	8 15 13.0	20	Weisse X. 288	+0 30.76	— 2 35.30	10 18 0.66	10 37 41.97
	22	8 14 22.4	12	" 276	—2 45.73	—12 11.84	10 14 1.00	11 6 20.48
	23	8 58 6.1	10	Rümker 3155	—1 9.58	—13 6.67	10 13 10.38	11 11 59.23
	25	8 53 10.8	10	" 3155	—2 41.85	— 2 52.64	10 11 38.12	11 22 13.52
	26	8 48 17.1	20	" 3122	+0 1.60	— 5 39.06	10 10 49.98	11 27 19.25
Mar.	3	8 23 49.9	20	Weisse X. 76	+1 11.24	—10 19.70	10 7 1.69	11 52 17.21
	6	8 12 45.2	12	" 76	—0 59.91	+ 4 0.74	10 4 50.53	12 6 37.70
	10	8 5 41.4	15	Rümker 3076	—0 59.60	— 6 59.02	10 2 4.31	12 24 33.34
	12	8 31 57.6	22	α Leonis.	+0 1.04	— 6 37.73	10 0 46.02	12 33 10.97
	14	8 23 22.3	16	"	—1 15.27	+ 1 28.12	9 59 31.79	12 41 16.87
	17	8 18 5.5	12	Weisse IX. 1204	+1 39.09	+ 3 57.04	9 57 47.44	12 52 36.51
	18	8 21 21.0	8	" 1204	+1 6.02	+ 7 34.28	9 57 14.36	12 56 13.77
	20	8 13 59.0	20	" 1204	+0 4.05	+14 22.09	9 56 12.38	13 3 1.21
	21	8 11 25.9	10	" 1204	—0 25.40	+17 38.86	9 55 42.92	+13 6 18.02

Adopted Mean Places, 1860.0, of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
B. A. C. 3575	7	10 20 15.20	B. A. Cat. and Santini.	+10 28 29.28	Y. 1. M. 1. (1)
Weisse X. 288	8	10 17 37.70	Weisse and Rümker.	10 41 28.24	Y. 1.
" 276	8	10 16 54.52	Weisse's Catalogue.	11 17 43.13	Y. 1.
Rümker 3155	9	10 14 27.73	Weisse and Rümker.	11 24 17.30	Y. 1.
" 3122	9	10 5 56.15	" "	11 32 9.97	M. 1. Y. 3.
Weisse X. 76	9	10 5 58.22	Weisse's Catalogue.	12 1 48.98	M. 1.
Rümker 3076	8	10 3 11.72	Rümker's Catalogue.	12 30 44.47	Y. 1.
α Leonis.	1	10 0 54.88	All known observations.	12 39 0.89	All known observations.
Weisse IX. 1204	8	9 56 16.22	Weisse's Catalogue.	+12 47 51.85	Y. 1.

F I D E S.

Date.	M. T. Washington.			No. of Comp.	Comparison-Star.	③7 — *		③7's apparent	
						$\Delta\alpha$	$\Delta\delta$	α	δ
1857, Feb.	3	^h 10	^m 7 ^s 33.6	4	Weisse XI. 234	—2 ^m 26.40	+ ^s 4 20.79	11 ^h 11 ^m 52.01	+ ^s 8 4 38.08
	11	10	3 25.8	5	B. A. C. 3837	—0 25.90	—14 50.52	11 6 11.54	8 35 34.54
	15	9	14 4.4	20	Rümker 3457	—0 10.28	+12 58.31	11 2 56.30	8 52 51.25
	17	9	14 27.1	4	“ 3457	—1 53.63	+21 46.51	11 1 12.99	9 1 39.36
	22	9	16 37.3	16	Weisse X. 1006	+0 24.11	— 5 22.64	10 56 42.71	9 24 27.22
	25	9	58 40.2	7	“ 987	—1 12.84	—17 56.65	10 53 54.32	9 38 24.25
	26	9	45 53.1	10	“ 987	—2 8.53	—13 25.45	10 52 58.66	9 42 55.42
	Mar. 10	9	24 4.1	10	“ 757	—0 28.18	— 1 29.50	10 42 1.03	10 33 10.36
	14	9	17 34.7	14	“ 673	+0 25.54	+ 0 57.61	10 38 39.44	10 47 15.88
	20	9	3 19.5	8	“ 618	—0 41.20	— 1 6.78	10 34 5.93	11 4 57.05
	21	10	1 8.5	5	“ 618	—1 24.61	+ 1 31.06	10 33 22.51	+11 7 34.93

(1) The letters Y. M. indicate that the declinations are determined from observations with the Washington Mural, made by Professors YARNALL and MAJOR. The numbers show how many observations were made. The reductions to 1860 are by Professor YARNALL.

Adopted Mean Places, 1860.0, of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
Weisse XI. 234	8	^h 11 ^m 14 ^s 26.38	Weisse's Catalogue.	+ 7° 59' 25".14	Y. 3.
B. A. C. 3837	7	11 6 45.25	B. A. C., Santini, and Rumker.	8 49 33.92	Y. 2.
Rümker 3457	8	11 3 14.32	Rümker and Santini.	8 39 2.10	Y. 2.
Weisse X. 1006	9	10 56 26.26	Weisse's Catalogue.	9 28 59.62	Y. 2.
" 987	8	10 53 14.80	" "	9 55 30.81	Y. 2. M. 1.
" 757	9	10 42 36.79	" "	10 33 50.67	Y. 1.
" 673	9	10 38 21.51	" "	10 45 28.74	Y. 2. M. 1.
" 618	9	10 34 54.76	" "	+11 5 14.28	Y. 2. M. 1.

COMET 1857, I.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$\Delta \alpha$	$\Delta \delta$	α	δ
	^h ^m ^s			^m ^s		^h ^m ^s	
March 27	8 15 17.4	5	Groombr. 344	+5 2.66	+ 1' 53".29	1 32 44.56	+46° 37' 36".84
April 2	8 13 59.4	5	B. A. C. 967	-9 4.08	+ 9 42.97	2 50 46.01	41 28 40.54
7	8 10 55.2	10	" 1026	+2 13.28	+13 14.25	3 14 4.85	43 1 58.05
5	7 53 57.6	2	Groombr. 698	+2 26.58	- 2 34.03	3 24 57.94	42 13 6.20
7	8 20 17.1	8	B. Z. 512, 93	+3 4.85	+ 1 52.22	3 45 32.35	40 23 45.73
14	8 32 44.6	5	B. A. C. 1520	-5 21.53	+20 12.56	4 42 19.31	33 16 30.68
15	8 31 13.3	14	B. Z. 400, 91	-0 40.27	+ 3 32.76	4 48 46.54	32 14 24.82
17	8 56 59.3	5	Rümker 2553 (1)	-1 7.91	+ 3 43.32	5 0 50.12	+30 10 51.49

Adopted Mean Places, 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
Groombr. 344	8	^h 1 ^m 27 ^s 54.40	+46° 36' 34".42	Radcliffe Observations, <i>passim</i> .
B. A. C. 967	5	3 0 3.78	44 19 29.41	Radcliffe, <i>passim</i> , Greenwich 12 Y., and B. A. C.
" 1026	6.7	3 12 4.56	42 49 13.91	Radcliffe, <i>passim</i> , and B. A. C.
Groombr. 698	7	3 22 44.34	42 16 9.43	Radcliffe, <i>passim</i> .
B. Z. 512, 93	8	3 42 40.29	40 22 15.84	Bessel's Zones.
B. A. C. 1520	4	4 47 52.83	32 56 25.43	B. A. C., Radcliffe, Greenwich 12 Y., Rümker, and Washington Observations.
B. Z. 400, 91	9	4 49 38.70	32 10 58.88	Bessel's Zones.
Rümker 2553 (1)	8.9	5 2 9.32	+30 7 19.27	Rümker (Neue Folge).

COMET 1857, II. (Rediscovered by BRUHNS, 1857.)

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$\Delta \alpha$	$\Delta \delta$	α	δ
	^h ^m ^s			^m ^s		^h ^m ^s	
1857, April 17	8 26 36.2	5	<i>a</i>	+1 19.58	-21 15.30	4 7 41.27	+43 58' 11".61
23	8 37 15.1	6	A. Z. 163, 31	+2 57.73	- 7 32.39	4 46 58.71	51 14 36.90
24	8 12 34.4	12	<i>b</i>	-0 14.93	- 6 43.80	4 51 46.38	52 21 52.50
25	9 7 53.1	5	A. Z. 163, 60	+2 39.37	+12 18.14	5 3 5.40	+53 28 33.31

Adopted Mean Place, 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
<i>a</i> (2)	8	^h 4 ^m 6 ^s 32.02	+44° 19' 32".78	Wash. Equat. from B. Z. 514, 66.
A. Z. 163, 31	8	4 44 15.67	51 22 14.94	Argelander's Zones.
Groombr. 892	6	4 45 2.22	52 38 13.39	Radcliffe, <i>passim</i> ; Argelander.
<i>b</i>	9	4 55 16.23	52 28 37.69	Wash. Equat. from Groombr. 892.
A. Z. 163, 60	8	5 0 41.15	+53 16 15.02	Argelander's Zones.

(1) Rümker's Additional Catalogue, published the present year.

(2) The position of this star depends on a single comparison.

EUPHROSYNÉ.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	③ — *		③'s apparent	
				$\Delta \alpha$	$\Delta \delta$	α	δ
1857, April 24	^h 10 ^m 30 ^s 21.3	11	A. Z. 301, 59	^m ^s +0 58.44	+2' 22.55	^h 14 ^m 42 ^s 4.39	—23° 37' 3.95
25	10 4 30.6	14	" 301, 59	+0 0.55	+1 1.48	14 41 6.50	23 38 25.14
27	10 0 21.3	10	" 301, 59	—1 59.45	—1 33.15	14 39 6.50	23 40 59.88
30	9 48 13.4	11	" 301, 47	+1 22.69	+8 42.17	14 36 5.14	—23 44 11.00

Adopted Mean Places, 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
A. Z. 301, 59	6	^h 14 ^m 41 ^s 14.17	—23° 39' 56.76	} Argelander's Zones.
" 301, 47	7	14 34 50.62	—23 53 23.78	

LETTER FROM MR. BOND TO THE EDITOR.

TO THE EDITOR OF THE ASTRONOMICAL JOURNAL:—

WHILE engaged in making comparative declination observations on the planet *Mars* at the opposition 1849–50, in connection with the U. S. Astronomical Expedition to Chile, it occurred to us that differential observations on *Mars* in right ascension, east and west of the meridian, might be employed for the determination of the solar parallax, more conveniently than those of declination, and that they would possess the advantages of being made by the same individual, with the same instrument, at the same place, and under very similar circumstances of refraction, personal equation, and general conditions. A series of observations was therefore instituted at this Observatory for the purpose of testing the feasibility of this method; the observations were made by Messrs. W. C. and G. P. BOND, under circumstances by no means favorable, and when completed they were placed in the hands of Mr. T. H. SAFFORD for computation. The details will be included in a future volume of the *Annals* of this Observatory. In the mean while I send you for publication the results which have been obtained by Mr. SAFFORD.

Harvard College Observatory, April 28th, 1857.

Solar Parallax deduced from Right-Ascension Observations on Mars East and West of the Meridian, near the Opposition of 1849–50.

	"	Weight.
1849, Nov. 15	8.16	1.4
16	8.70	0.3
21	8.13	1.5
27	8.79	1.9
30	8.97	6.0
Dec. 11	8.43	5.6
12	8.25	3.3
17	7.83	4.8
18	9.35	2.2
27	9.32	3.1
1850, Jan. 1	7.33	1.4
4	9.42	1.4
10	9.59	1.3

Mean, 8.605 Sum, 34.2

Probable Error, $\pm 0''.4$.

The parallax adopted by ENCKE is $8''.58$.

That derived from declination observations on *Mars*, at the opposition in 1832, made at the Cape of Good Hope by HENDERSON, and at the Observatories of Greenwich, Cambridge (Eng.), and Altona, is $9''.12$.

W. C. BOND.

SECOND COMET OF 1857.

PROFESSOR BRUHNS, of the Berlin Observatory, in an interesting letter dated April 3, has communicated elements, both parabolic and elliptic, which he had computed for this comet, discovered by him March 18th. Various circumstances having long, but unavoidably, delayed the publication of the pres-

ent number of this Journal, the ephemeris, which only extended to June 1, has now nearly reached its limit, and it is therefore not now given. The identity of this comet with 1846, III. has now been put beyond all question.

G.

FIRST COMET OF 1857.

LETTER FROM MR. WATSON TO THE EDITOR.

Ann Arbor, 1857, April 20.

Enclosed I send you elements of the new comet, computed from the observations at Leipsic and Berlin, February 26, Altona, March 13, and Washington, March 27.

Elements of the Comet 1857, I.

<i>T</i>	March 21.575364, Washington M. T.
π	$74^{\circ} 20' 35.2''$
Ω	$312^{\circ} 36' 17.4''$
<i>i</i>	$87^{\circ} 34' 48.4''$
$\log q$	9.890676
	Motion Direct.

It has been observed here but twice, owing to an uninterrupted series of cloudy evenings, since the announcement of its discovery.

JAMES C. WATSON.

FORTY-THIRD ASTEROID.

PROFESSOR PETERS communicates, in a circular of the *Astronomische Nachrichten*, the following elements of this planet, computed by Mr. PAPE from observations at Oxford, April 15, Altona and Liverpool, April 19, and Bilk, April 22.

Epoch = 1857. April 22.5, Berlin M. T.

<i>M</i>	$309^{\circ} 16' 23.9''$
π	$276^{\circ} 34' 59.1''$
Ω	$264^{\circ} 18' 58.0''$
<i>i</i>	$3^{\circ} 27' 41.9''$
<i>q</i>	$9^{\circ} 46' 22.6''$
$\log a$	0.343405
" μ	3.034899

GAUSS'S COMPLETE WORKS.

THE Royal Society of Sciences in Göttingen contemplate the publication of an edition of GAUSS'S complete works, provided sufficient encouragement be offered, — a condition concerning which there can scarcely be a reasonable doubt.

The plan comprises not merely a reprint of works already published, important as this will be, in view of the difficulty and indeed impossibility of obtaining some of them, but the collection and issue of all which can now be collected that has flowed from his pen, including, of course, the manuscript investigations found among his papers, &c. To this end, the Society has appointed a commission, consisting of Professors DIRICHLET, WEBER, and SARTORIUS VON WALTERSHAUSEN, who will, in case the requisite number of subscribers shall volunteer, make full arrangements for editing and publishing the work in a style commensurate with its value, with the

honor due the memory of the immortal author, and with the dignity of the Royal Society of Sciences.

The series will consist of five, or possibly six, quarto volumes, and be furnished at the price of 25 thalers, Prussian Courant, — which, together with the expenses of importation, would amount to about \$ 20, deliverable in the United States.

Inasmuch as the present success of this admirable proposition will depend upon the number of subscribers, the editor of this Journal ventures to express his hope that the support and encouragement afforded by the lovers of science in the United States may be proportionate to the merits of the enterprise and to their veneration for the memory of the illustrious mathematician and astronomer. And he solicits all who desire to contribute to this end to send him their names, or those of the public institutions on whose behalf they may be disposed to subscribe, at an early date.

G.

Cambridge, 1857, May 1.

NEW WORKS.

1. ARGELANDER'S *Atlas des Nördlichen gestirnten Himmels für den Anfang des Jahres*. 1855. — The first part of this great work, so earnestly desired and eagerly anticipated by astronomers, has recently been published, accompanied by a detailed description of the methods of observation and reduction of the stars, and construction of the charts. The Northern and Southern Zones of Professor ARGELANDER having been so far extended that these, together with BESSEL'S, comprise all those portions of the heavens which may be satisfactorily examined in the latitude of European observatories (i. e. all the region north of the thirty-first parallel of south declination), this eminent astronomer conceived the vast plan of a detailed census of the Northern heavens. The plan contemplates the approximate observation of every star to the 9 magnitude, inclusive, and of as many as possible of the $9\frac{1}{2}$ magnitude, and the charting and cataloguing them all with especial reference to magnitude; the whole work to be independent of all other charts, catalogues, and observations. The rich treasure which Professor ARGELANDER has thus undertaken to offer to astronomy may be imagined. To the sidereal observer it is a working catalogue of the most complete and convenient kind; for the choice of comparison-stars, it is an index of a class which has never before existed; for the detection and recognition of minute wandering bodies, like the asteroids, it is priceless; while its collation with past and future catalogues will necessarily solve many a doubt, and unravel many a knotty problem. After a mature consideration and organization of the plan of the work, Professor ARGELANDER began the gigantic undertaking some years since, and has prosecuted it with devoted assiduity, aided by his accomplished pupils, prominent among whom are Drs. SCHÖNFELD and KRÜGER.

The copies of the published portion have not yet been received in America, and it is therefore impossible to give a full description from inspection. But I take the liberty of translating the carefully prepared account given by Professor PETERS in the *Astron. Nachrichten*, No. 1064, as furnishing unquestionably a far better abstract of Professor ARGELANDER'S description than it would otherwise be possible to offer.

"The charts are to comprise the entire Northern hemisphere, together with the first two degrees of south declination. It is intended that they shall contain *all* the stars down to the 9 magnitude which are within this region, as many as possible of the brighter ones of the 9.10 magnitude, and so many of the others of this class as circumstances permit; but, on the other hand, not one which is not actually in the heavens.

"The scale of the chart is 9 lines Rhenish (0.772 in.) to the degree of a great circle, and consequently in the ratio of 1 to $1\frac{1}{2}$ greater than that of the Berlin charts. The series will be divided into five sections, having different projections. The first section extends from 2° South to 20° North declination;

and in this no regard is paid to the diminution of the parallels. It will consist of twelve charts, each containing two hours of right-ascension, but with four additional minutes given on each side. In the remaining sections the parallels are concentric circles, and the meridians straight lines which intersect them at right angles. The whole Atlas will consist, including the title, of forty-one sheets. It is to appear in parts containing four charts each, and, according to the programme of Professor ARGELANDER, will be completed about the year 1862.

"The positions of all the stars entered upon the charts are determined at the Bonn Observatory. The greater portion of these observations is made in zones, which are about 2° 20' in breadth between the equator and the declination of 50°, and from 3° 10' to 3° 20' in the region farther north. The instrument employed is a parallaetically-mounted comet-seeker, by FRAUNHOFER, provided with a KELLNER'S eye-piece, the aperture being 34 lines, the focal distance 24 inches, and a magnifying power of 10 times. In the focus of the eye-piece a half disc of thin plate-glass is so inserted that its marginal diameter corresponds with a circle of declination. This edge being ground, but not polished, forms in the telescope a slight dark line, readily distinguishable against the sky without artificial illumination. Perpendicular to this a radius is drawn upon the surface of the glass, and on each side, parallel to this radius, ten shorter lines, at a distance of about 7' apart, each third one being somewhat longer than the others for more convenient distinction. These lines are painted in thick, black oil-colors, and are about $1\frac{1}{2}$ minutes in breadth.

"The observations are with a dark field and an apartment in which is no artificial illumination, the eye being shielded from the brightness of the sky by a screen of black pasteboard.

"Previous to the commencement of the observations, the declination-circle is clamped to the mean declination of the zone to be observed, and the telescope set to the initial right-ascension by means of the hour-circle. Then for each star which passes through the field of view, the magnitude, the minute of disappearance behind the transit-line, and the estimated position with reference to the transit scale, are noted.

"Every region of the heavens is reviewed at least twice, and in such a manner that the middle of the zone shall fall first upon an even, and then upon an uneven, degree of declination. If upon the comparison of the two examinations it appears that, from an unfavorable state of the atmosphere, either zone does not afford satisfactory results, the observation of this zone is repeated with the correct scale.

"The region of the Milky Way, and all those portions of the heavens in which the principal zones have shown more than 900 to 1000 stars to the hour, are reviewed still again with more powerful telescopes, and in zones one degree broad. In the same manner also all those regions are re-examined in

which the comparison of the original zones shows considerable differences in the positions.

"The places thus given by the single zone-observations are compared not merely with each other, but with the best catalogues and charts; all those stars of which these comparisons indicate the need of further investigation, whether in reference to their position or their magnitude, are subsequently examined with the meridian circle of the heliometer. After all doubts are thus solved, the fundamental catalogue is prepared, and from this the stars are entered upon the chart blanks according to their position and magnitude.

"Professor ARGELANDER has personally tested the fundamental catalogue and the charts constructed from it, as regards the completeness intended, as also the accuracy of the positions and the magnitude. The result of these tests must be considered extremely favorable. He found that out of 26,000 stars down to the 9 magnitude inclusive, 7 were wanting on the charts, whence it is to be inferred that in the whole Atlas perhaps 30 out of the 110,000 or 120,000 will be wanting. The probable error in right ascension of an equatorial star upon the chart is $1''.25$, in declination $0'.50$. The probable error in the magnitude of stars between $8\frac{1}{2}$ and $9\frac{1}{2}$ does not exceed 0.1. For the brighter stars this error is somewhat larger, amounting to 0.26."

2. *Star-Charts of the Berlin Academy.*—The chart for the V. hour of right-ascension ($5^h - 6^h$), having been prepared by Professor ARGELANDER and Mr. SCHMIDT, has recently been published, together with explanatory remarks by Professor ENCKE. The observations and reduction were begun in Åbo by Professor ARGELANDER, interrupted by his call to Bonn, and subsequently completed with the assistance of Mr. SCHMIDT, who has now charted the results, and catalogued the new stars introduced.

Only the IX. and 0 hours of right-ascension remain to complete the series of the Berlin charts.

3. *Neue Folge der mittleren Oerter von Fixsternen für den Anfang von 1850; Abgeleitet aus den Beobachtungen auf der Hamburger Sternwarte von Carl Rümker.*—This continuation of the former catalogue of Professor RÜMKE is arranged in the same manner as the preceding, with the single exception of

the new epoch for the mean equinox. The paging of the former volume is also continued.

The part recently published extends from 0^h to 6^h , and contains the mean places of 2553 additional stars, determined with the Repsold meridian-circle of the Hamburg Observatory, accompanied by their annual precessions and logarithms for reduction from mean to apparent places. May the health and usefulness of their honored author be extended until this new series shall, like its predecessor, reach the full number of 12,000 absolute determinations of stellar positions.

4. VEGA'S *Logarithmisch-Trigonometrisches Handbuch*, 40^{te} Auflage. *Neue vollständig durchgesehene und erweiterte Stereotyp-Ausgabe, bearbeitet von Dr. C. Bremiker.*—Dr. BREMIKER has in this work, which should bear his own name more appropriately than that of VEGA, rendered another essential service to computers, not merely by the greatly increased accuracy of the last figures, but by the exquisitely elegant arrangement, analogous to that of the tables for six decimals previously published. It would be very difficult to devise a more convenient and elegant form of arrangement than the one here adopted, which is throughout similar or analogous to that used in his other tables. Many little conveniences are also introduced which the professional computer will know how to esteem, such, for instance, as the logarithms for converting the logarithm of any number of seconds into that of the sine or tangent; the decimal in the tables of proportional parts; the useful and carefully chosen constants, including the planetary masses according to the most trustworthy determinations, &c.

But the characteristic feature of the work is the practical convenience of the arrangement, which is so perfect, that no one who has once become accustomed to it will be willing to abandon it, despite any possible difference of taste or preference as to the form of the figures adopted, which are the old-fashioned ones of unequal length. In the Preface Dr. BREMIKER has given an interesting historical account of the principal logarithm-tables hitherto employed, and illustrations of their relative precision.

It is not too much to assume that the two logarithm books of Dr. BREMIKER will become classic, and very long remain so. G.

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PLANET-CIRCULAR.

Cambridge, 1857, June 22.

LETTER FROM MR. GOLDSCHMIDT TO THE EDITOR.

Paris, 1857, June 3.

I MUST not delay to inform you of the discovery of the 44th asteroid (my sixth), which I found on the night of May 27. The planet resembles a star of the 10.11 magnitude. Approximate positions are :

	Paris M. T.	α	δ
1857 May 27	11 ^h 0 ^m	15° 15' 58"	— 12° 8'
" June 1	10 55	15 12 9.2	—

The latter place depends upon a comparison with LALANDE 28036, which was too distant for determining the declination ; and I therefore compared it with an anonymous star of the 10 magnitude, which will be determined at the Observatory here. This comparison gave :

Paris M. T.	Planet — Star
10 ^h 32 ^m	$\Delta\alpha = 30''$ $\Delta\delta = 2' 56''$

The comparisons on May 31 were not successful, partly on account of the want of fixity in my telescope, which has only an ordinary mounting, and partly by reason of the too great distance of the comparison-star. I will, however, append them.

	Paris M. T.	α	δ
May 31	11 ^h 15 ^m	15 ^h 12 ^m 43 ^s	—
	15 50	—	— 12° 3'

HERMANN GOLDSCHMIDT.

The forty-third Asteroid, discovered at the Radcliffe Observatory by Mr. POGSON, has received the name *Ariadne*.

G.

ON THE METHOD OF FINDING THE LONGITUDE OF A PLACE BY TRANSITS OF THE MOON AND A STAR OVER THE SAME VERTICAL CIRCLE.

BY W. CHAUVENET,

PROFESSOR OF ASTRONOMY AND NAVIGATION IN THE U. S. NAVAL ACADEMY.

1. IN the use of small (portable) instruments for determining time, longitude and latitude, those methods of observation are in general to be preferred which are independent of graduated circles. In illustration of this remark, we may cite the methods of finding the latitude by transits over the prime vertical ; of finding the time by equal altitudes ; the latitude by the difference of the zenith distances of two stars, one north and the other south of the zenith, this difference being measured by the micrometer and level ; the latitude by equal zenith distances of two stars, one of the stars or

both being off the meridian, but at azimuths differing nearly 180° ; and finally the method of finding the longitude from equal altitudes of the moon and a star, developed by Dr. Oudemans in the *Astr. Journal*, No. 93.

In the article of Dr. Oudemans just referred to, a remark of Professor Kaiser is quoted to the effect "that a traveling astronomer can very easily multiply his determinations in a single night, by observing transits of the moon and neighboring stars across the same vertical;" and it is also added that "Mr. De Lange, during his stay in Leyden, made use of this method, and found that in a latitude as high as that of Leyden it offers no difficulty, while it might readily be foreseen that it would be attended with great advantages." As no one appears to have published formulas for the reduction of such observations, I am induced to offer here my own, which, however, are so naturally suggested by the nature of the observations, that it is possible that they will be found to be essentially the same as those employed by the astronomers above alluded to.

2. To prepare for the observation, it is necessary first to determine with all possible precision the correction and rate of the chronometer.

For the comparison with the moon, a well determined star is to be selected, nearly in the same parallel with the moon, and not far distant in right-ascension. A preliminary computation of the hour-angles and altitudes corresponding to assumed azimuths (say 15° , 10° and 5° from the meridian) will serve to enable the observer to point the instrument properly. The formulas for this purpose are too well known to be repeated here.

3. The Altitude and Azimuth Instrument, and the Ertel Universal Instrument, are peculiarly adapted for these observations; but the common portable transit-instrument is even preferable when it is furnished with a small horizontal circle, by which it may be approximately placed at a given azimuth*. The observations may be conducted as follows: 1° The instrument being mounted and the horizontal axis leveled, the reading of the horizontal circle corresponding to the azimuth 0° is to be found by any convenient method; for example, by pointing the telescope upon a slow-moving star at the computed time of its meridian transit. Great ac-

curacy in this operation is of course unnecessary, since we use the horizontal circle merely as a *finder*. 2° The telescope is then pointed for the first assumed azimuth, and the altitude of either the moon or the star, whichever precedes. 3° The inclination of the horizontal axis is measured with the striding level. 4° The times of transit of the first object, moon or star, over the several threads, are noted by the chronometer. 5° The approximate apparent zenith-distance of the object is read from the vertical circle, the observer having caused the object to cross the middle thread near its intersection with the fixed horizontal thread. 6° The telescope is pointed for the altitude of the second object, star or moon, observing carefully not to disturb the instrument in azimuth; and if there is time, the level of the axis is to be re-examined. 7° The times of transit of the second object over the vertical threads are noted by the chronometer. 8° The approximate zenith distance of the object is read from the vertical circle. 9° The inclination of the horizontal axis may be again observed.

The repeated examination of the level, here recommended, is not always necessary, but the traveling astronomer is not unfrequently compelled to employ rather unstable supports for his instrument; and it will be a safe rule to observe the inclination of the axis for both the moon and the star, since the correction for this inclination is very easily computed.

In order to eliminate any error of collimation, or inequality of pivots, the rotation axis of the telescope is now to be reversed; and another observation, similar to the first, is to be taken at another assumed azimuth. In this way the observations may be repeated from the extreme eastern to the extreme western azimuth, which, however, should not exceed about 15° . The observations on opposite sides of the meridian should be arranged in symmetrical pairs; that is, for each observation at the east azimuth $-\Lambda$, there should be a corresponding one at the west azimuth $+\Lambda$, and at these two observations the rotation axis should have reversed positions.

4. A rigorous reduction of the observations requires, first, that the transits over the different threads should be severally reduced to the middle thread; for which purpose, the theory of the altitude- and azimuth-instrument furnishes a suitable formula. If, however, the threads are symmetrically placed, and all are employed, it will suffice (unless the observations are extended greatly beyond the limits above recommended) to take the means of the observed times for the times hereafter designated by T and T' . The slight theoretical error which this procedure involves will be eliminated, if the observations are arranged symmetrically with respect to the meridian.

In order farther to reduce the observations, let us denote by

* The Zenith Telescope, the application of which in the method of finding the longitude by equal altitudes of the moon and star is pointed out by Dr. Gould in a note to Dr. Oudemans' article (*A. J.* Vol. iv, p. 165), may also be applied to the method here considered. It is necessary to observe, however, that as the instrument is now constructed, it cannot be used at the zenith-distances required in both these methods. A very simple modification in the arrangement of the level will obviate the difficulty.

α requires the correction $\Delta\alpha \cdot \delta\omega$,

δ $\Delta\delta \cdot \delta\omega$;

and hence, also,

t $-\Delta\alpha \cdot \delta\omega$;

and these corrections must produce the correction $-\zeta$ in the moon's azimuth. The differential formulas of spherical trigonometry give us

$$d\Lambda = \frac{\cos \delta \cos q}{\sin z} 15 dt + \frac{\sin q}{\sin z} d\delta$$

whence we infer

$$-\zeta = -\frac{\cos \delta \cos q}{\sin z} 15 \Delta\alpha \cdot \delta\omega + \frac{\sin q}{\sin z} \Delta\delta \cdot \delta\omega$$

so that if we put

$$a = \frac{15 \cos \delta \cos q}{\sin z} \Delta\alpha - \frac{\sin q}{\sin z} \Delta\delta \quad (2)$$

we have

$$\delta\omega = \frac{\zeta}{a} \quad (3)$$

5. But the quantity ζ results not only from the error in the assumed longitude, but also from the errors of observation and of the Ephemeris. In order to obtain a general expression in which the effect of each source of error may be represented, let us denote by

$\delta\alpha$, $\delta\delta$, $\delta\pi$, δS , the corrections of the elements taken from the Ephemeris for the date of the observation;

$\delta\alpha'$, $\delta\delta'$, the corrections of the star's place;

δT , $\delta T'$, the corrections for errors in the observed times;

$\delta \Delta T$, the correction of ΔT ;

$\delta\varphi$, the correction of the latitude.

If, when the corrected values of all the elements (that of the longitude included) are substituted in the above computation, Λ , and Λ' become $\Lambda + d\Lambda$ and $\Lambda' + d\Lambda'$, we ought to find

$$\Lambda + d\Lambda = \Lambda' + d\Lambda'$$

which, compared with (1), gives

$$\zeta = -d\Lambda + d\Lambda' \quad (4)$$

We have then to find expressions for $d\Lambda$, and $d\Lambda'$ in terms of the above named corrections. By differentiating the formula for Λ , we find

$$d\Lambda = d\Lambda \pm \frac{dS}{\sin z} + \frac{q(q-q') \sin 1'' \sin \Lambda'}{\sin z} d\pi$$

in which we neglect not only the effects of changes of z as practically insensible, since the observations are not very remote from the meridian, but also the effect of an error in Λ' upon the parallax in azimuth, since this quantity itself is a quantity of the second order.

We have already found, in the preceding paragraph, the expression for $d\Lambda$ taken with reference to δ and t : the differential with reference to φ is

$$-\cot z \sin \Lambda d\varphi$$

so that the total differential taken with reference to δ , t and φ , is

$$d\Lambda = \frac{15 \cos \delta \cos q}{\sin z} dt + \frac{\sin q}{\sin z} d\delta - \cot z \sin \Lambda d\varphi$$

Consequently, also,

$$d\Lambda' = d\Lambda' = \frac{15 \cos \delta' \cos q'}{\sin z'} dt' + \frac{\sin q'}{\sin z'} d\delta' - \cot z' \sin \Lambda' d\varphi$$

Since $t = T + \Delta T - \alpha$, we have

$$dt = dT + d\Delta T - d\alpha$$

where dT and $d\Delta T$ may be exchanged for δT and $\delta \Delta T$; but $d\alpha$ is composed of two parts: 1° of the actual correction of the Ephemeris; 2° of $\Delta\alpha (\delta\omega + \delta T + \delta \Delta T)$, resulting from our having taken α for the uncorrected time. Hence we obtain

$$dt = \delta T + d\delta T - \delta\alpha - \Delta\alpha (\delta\omega + \delta T + \delta \Delta T)$$

which is to be substituted in the expression for $d\Lambda$.

The correction $d\delta$ is also composed of two parts, namely,

$$d\delta = \delta\delta + \Delta\delta (\delta\omega + \delta T + \delta \Delta T)$$

Further we have simply $d\delta = \delta\delta'$, and

$$dt' = \delta T' + \delta \Delta T' - \delta\alpha'$$

but as a very brief interval elapses between the observation of the moon and the star, the error in the *rate* of the chronometer may be neglected, and we may take $\delta \Delta T' = \delta \Delta T$, or

$$dt' = \delta T' + \delta \Delta T - \delta\alpha'$$

These substitutions being made in the value of $d\Lambda$ and $d\Lambda'$, the expression for ζ takes the following form:

$$\begin{aligned} \zeta = & \left(\frac{15 \cos \delta \cos q}{\sin z} \Delta\alpha - \frac{\sin q}{\sin z} \Delta\delta \right) \delta\omega - \left(\frac{15 \cos \delta \cos q}{\sin z} (1 - \Delta\alpha) + \frac{\sin q}{\sin z} \Delta\delta \right) \delta T + \frac{15 \cos \delta' \cos q'}{\sin z'} \delta T' \\ & - \left(\frac{15 \cos \delta \cos q}{\sin z} (1 - \Delta\alpha) + \frac{\sin q}{\sin z} \Delta\delta - \frac{15 \cos \delta' \cos q'}{\sin z'} \right) \delta \Delta T + \frac{15 \cos \delta \cos q}{\sin z} \delta\alpha - \frac{\sin q}{\sin z} \delta\delta \mp \frac{dS}{\sin z} \\ & - \frac{q(q-q') \sin 1'' \sin \Lambda'}{\sin z} \delta\pi - \frac{15 \cos \delta' \cos q'}{\sin z'} \delta\alpha' + \frac{\sin q'}{\sin z'} \delta\delta' + (\cot z \sin \Lambda - \cot z' \sin \Lambda') d\varphi. \end{aligned}$$

In the last term we may put Λ' for Λ , and the computation will be facilitated by introducing the auxiliaries

$$f = \frac{15 \cos \delta \cos q}{\sin z}, \quad f' = \frac{15 \cos \delta' \cos q'}{\sin z'},$$

$$a = f \cdot \Delta\alpha - \frac{\sin q}{\sin z} \Delta\delta$$

by means of which we shall have

$$\begin{aligned} \zeta &= a\delta\omega + (a-f)\delta T + f'\delta T' + (a-f+f')\delta \cdot IT \\ &\quad + f\delta\alpha - \frac{\sin q}{\sin z}\delta\delta - f'\delta\alpha' + \frac{\sin q'}{\sin z'}\delta\delta' \\ &\mp \frac{\delta S}{\sin z} - \frac{q(q-q')\sin 1'' \sin \Lambda'}{\sin z} \delta\pi + \frac{\sin(z-z')\sin \Lambda'}{\sin z \sin z'} \delta\varphi \end{aligned} \quad (5)$$

With the aid of this equation, we can now trace the influence of each source of error :

1^o An error δT in the observed time of the moon's transit, produces in $\delta\omega$ the error

$$\left(1 - \frac{f}{a}\right) \delta T$$

When $\Lambda = 0$, we have $q = 0$, and then this error is

$$\left(1 - \frac{1}{\Delta\alpha}\right) \delta T = \delta T - \frac{\delta T}{\Delta\alpha}$$

which is therefore the effect of an error in a meridian transit, and is nearly the mean effect of errors of observations equidistant from the meridian.

2^o An error in the star's transit produces nearly the same effect (without regard to sign) as an error in that of the moon, when the observations are not too far from the meridian.

3^o Since f and f' are nearly equal, we see that when different stars are employed, the mean of whose declinations is nearly the same as the moon's, the mean value of $f-f'$ will be nearly zero, and will have no sensible effect upon the term in $\delta \cdot IT$; so that the effect of an error $\delta \cdot IT$ in the chronometer correction upon ζ will be simply $a\delta \cdot IT$, and upon the longitude simply $\delta \cdot IT$.

4^o The tabular errors of right ascension produce nearly the same effect as errors in the observed times of transit; and since the essential signs of f and f' are always positive, these errors can be eliminated only by finding the values of $\delta\alpha$ and α' from direct observations. The value of $\delta\alpha$ can be found from any meridian observations of the moon at a standard observatory, taken during the semilunation in which the observations for longitude are made, by PEIRCE'S method. (U.S. Coast Survey Report for 1854, Appendix, p. 115*.)

5^o Since $\sin q$ has nearly equal numerical values with opposite signs for observations equidistant from the meridian, the effect of errors of declination (whether of the moon or of the star) will be nearly eliminated from the mean of such observations.

6^o The error of the moon's semidiameter will be eliminated if observations of both limbs are combined, in equal number.

7^o The error of the horizontal parallax is eliminated by combining observations equidistant from the meridian.

8^o The error in the latitude will have no effect when the observations are in the meridian: in other cases, the effect is zero when $z = z'$, which occurs when the star's and moon's declinations are equal. Hence an error in the latitude is eliminated by employing different stars in such positions that the mean of their declinations is nearly the same as that of the moon.

These considerations prove that the mean result of observations, properly grouped according to this method, is subject to no errors which do not equally affect meridian observations; while by the repetition of the observations, we reduce the error of observation below that of a single meridian transit. The method commends itself especially to the traveling astronomer, who may wish to obtain an accurate result in the shortest possible time.

It ought to be observed, however, that it would be a waste of time to make a very large number of observations on the same night. It appears that one portion of the error to which an observer is liable in noting the time of the moon's transit over a thread is nearly constant for the same day, and depends on the moon's age. If then we take in one night a sufficient number of transits over vertical circles to reduce the mean error of observation to an amount considerably below this constant error, we have exhausted the method for this night, and any further multiplication of observations would be useless. The point at which this limit is to be established must depend on the skill of the observer, the power of his instrument, the stability of its mounting, and even on atmospheric conditions; so that there is here abundant room for the exercise of his judgment. I think we may safely say, however, that cases will be rare in which more than six complete observations, three on each side of the meridian, will sensibly increase the accuracy of the mean result. With good instruments and average skill, two on each side of the meridian ought to suffice.

6. It remains to be considered, how the observations on the same night are to be combined, so as to obtain the most probable mean, having regard to their relative weight; for not only will the coefficient of $\delta\omega$ in our equation (5) have different values for the different observations, but the weights of the observations will vary with the distance from the meridian and the number of threads upon which the transits may happen to be observed. The preceding discussion shows that the terms involving $\delta\alpha$ and $\delta\alpha'$ are the only ones which are not either eliminated, or reduced to a minimum by a proper combination of observations. Omitting $\delta\alpha'$ as being very small, and having probably different signs for different stars, we may consider our equations of condition under the simple form

$$a\delta\omega = \zeta - f\delta\alpha. \quad (6)$$

For all the observations on the same day, $\delta\alpha$ is to be regarded as constant; so that having computed ζ , f and a for each observation, we have the equations

$$\begin{aligned} a_1 \delta\omega &= \zeta_1 - f_1 \delta\alpha, \\ a_2 \delta\omega &= \zeta_2 - f_2 \delta\alpha, \\ a_3 \delta\omega &= \zeta_3 - f_3 \delta\alpha, \\ &\text{etc.} \end{aligned}$$

To find expressions for the weight of one of these equations, let

ε = the mean error of a transit of the *moon* over a single thread;

ε' = the mean error of a transit of a *star* over a single thread;

v, v' = the number of threads on which the moon and the star are observed, respectively:

then the mean errors of T and T' are

$$\frac{\varepsilon}{\sqrt{v}}, \quad \frac{\varepsilon'}{\sqrt{v'}}$$

and the effect of these errors upon ζ are, severally, according to our equation (5),

$$(a-f) \frac{\varepsilon}{\sqrt{v}}, \quad f' \cdot \frac{\varepsilon'}{\sqrt{v'}}$$

for which, since a is small in comparison with f , while f' is nearly equal to f , we may here take

$$-\frac{f\varepsilon}{\sqrt{v}}, \quad \frac{f'\varepsilon'}{\sqrt{v'}}$$

and the combined effect of these errors produces in ζ the mean error

$$f \sqrt{\left(\frac{\varepsilon^2}{v} + \frac{\varepsilon'^2}{v'}\right)}$$

and the weight of the equation of condition formed from ζ is therefore proportional to

$$\frac{vv'}{f^2 (v\varepsilon'^2 + v'\varepsilon^2)}$$

It has heretofore been the practice of astronomers, in estimating the relative weights of moon-transits, to regard the mean error of the transit of the moon as the same as that of a star; that is, to take $\varepsilon = \varepsilon'$. As we are here considering only that part of the error which is not constant, this assumption is probably not so far wrong as to require us to go beyond it in actual practice. We shall, however, put $\varepsilon\varepsilon' = k\varepsilon'\varepsilon'$; and then regarding $\varepsilon'\varepsilon'$ as constant, we may express the weight of an observation by the formula

$$p = \frac{vv'}{f^2 (v + kv')} \quad (7)$$

in which we may take $k = 1$, unless a special investigation in an individual case may furnish a different value*.

We are now to multiply our equations respectively by $\frac{1}{p_1}, \frac{1}{p_2}, \frac{1}{p_3}$, etc. as found by this formula for each observation; and then multiplying them respectively by the coefficient of $\delta\omega$, their sum, according to the usual notation of the method of least squares, is

$$[aap] \delta\omega = [ap\zeta] - [afp] \delta\alpha$$

The immediate result of a single night's work, uncorrected for the error of the ephemeris, is

$$\delta\omega = \frac{[ap\zeta]}{[aap]}, \quad \text{with the weight } [aap] \quad (8)$$

to which, when $\delta\alpha$ has been found, we have to apply the correction

$$- \frac{[afp]}{[aap]} \delta\alpha.$$

The unit of weight here corresponds to the error ε' : when this is known, we have for a single result (on one day).

$$\text{Mean error of } \delta\omega = \frac{\varepsilon'}{\sqrt{[aap]}}$$

which, however, is to be increased on account of the error in the correction of the ephemeris. If then

$$e = \text{the mean error of } \delta\alpha$$

we have

$$\text{Mean error of } \delta\omega = \sqrt{\frac{\varepsilon'\varepsilon'}{[aap]} + \left(\frac{[afp]}{[aap]}\right)^2 e^2} \quad (9)$$

Results on different days may be combined by employing weights assigned according to the mean errors thus determined.

In practice, however, the following simpler process will give results not sensibly differing from those furnished by the above. If we put $\frac{a}{f} = .4a$, which is nearly its mean value for observations on the same day when they are equidistant from the meridian, and also put

$$p' = \frac{vv'}{v + kv'} \quad (10)$$

we have

$$p = \left(\frac{.4a}{a}\right)^2 p'$$

and then $.4a$ being regarded as constant, we have

$$[ap\zeta] = (.4a)^2 [p'\zeta]$$

$$[aap] = (.4a)^2 [p']$$

so that by (8) we have

$$\delta\omega = \frac{[p'\zeta]}{[p']} \quad (11)$$

If then we find from each observation the value of $\delta\omega$ by the formula

$$\delta\omega = \frac{\zeta}{a}$$

we can find the general mean of these values by the usual process, employing for the relative weights the formula (10). But the weight of this mean, when it is combined with the means of different days, must still be denoted by $[aap]$ or $(.4a)^2 [p']$.

* From a discussion of a number of observations of moon culminations by the experienced observers at Greenwich, I have found for one of the observers $k = 1.3$. For one of the Washington observers, I found for the moon's first limb, $k = 0.88$; but for the second limb, $k = 1.06$.

7. It may be well to add here a single example, in order to illustrate the use of our general formulas, and to show the values which the coefficients of equation (5) obtain.

At the U.S. Naval Academy, May 9, 1857, the transits of the moon's second limb, and of σ *Scorpii*, were observed over the same vertical circle at an approximate azimuth of 10° east of the meridian, with an Ertel Universal Instrument of 15 inches focal length, as follows :

Chronometer :	Level :	Collimation :
D H. T = $16^h 11^m 30^s.17$	$\iota = +2''.2$	$c = 0$
σ Scorp. T' = $16^h 27^m 49^s.83$		

These times are the means of three threads. The correction of the chronometer on sidereal time was $-55^m 9^s.16$ at 13^h , with an hourly rate of $-0^s.32$.

The latitude is $\varphi = 38^\circ 58' 53''.5$, and the assumed longitude, $\omega = 5^h 5^m 55^s$.

With these data, we find first

$$\begin{aligned} JT &= -15^m 9^s.89 & JT' &= -55^m 9^s.97 \\ T+JT &= 15^h 16^m 20^s.28 & T'+JT' &= 15^h 32^m 39^s.86 \end{aligned}$$

The Greenwich time corresponding to the sidereal time $T+JT$ is May 9, $17^h 10^m 27^s.09$; for which we take from the Ephemeris the following quantities :

$$\begin{aligned} \alpha &= 15^h 54^m 45^s.32 & \delta &= -24^\circ 42' 54''.1 \\ A\alpha &= 0.03513 & A\delta &= -0''.127 \\ \pi &= 54' 9''.2; & S &= 14' 47''.2; \end{aligned}$$

and from the B. A. Catalogue,

$$\alpha' = 16^h 12^m 32^s.62 \quad \delta' = -25^\circ 14' 58''.5.$$

The computation of the formulas of Article 4 gives then

$$\begin{aligned} \Lambda &= -9^\circ 40' 51''.2 & \Lambda' &= -9^\circ 57' 25''.4 \\ \log \tan q &= n 9.1626 & \log \tan q' &= n 9.1769 \\ z &= 64^\circ 19'.5 & z' &= 64^\circ 54'.1 \\ p \sin z &= +48.8 & & \\ \text{Refraction} &= -2.1 & \text{Refraction} &= -2.1 \\ z_l &= 65^\circ 6'.2 & z'_l &= 64^\circ 52'.0 \\ -b \cot z_l &= -1''.0 & -b \cot z'_l &= -1''.0 \\ -S &= -16' 24''.2 & & \\ \log q &= 9.9994 & \frac{q(q-q') \sin \pi \sin \Lambda'}{\sin z} &= -2''.0 \\ \varphi - \varphi' &= 11' 15'' & \Lambda_l &= -9^\circ 57' 18''.4 \\ \Lambda_l &= -9^\circ 57' 18''.4 & \Lambda'_l &= -9^\circ 57' 26''.4 \\ \xi &= +8''.0. \end{aligned}$$

For the coefficients of the equation (5), we find

$$\begin{aligned} f &= 14.963 & f' &= 14.818 \\ a &= 0.505 & & \\ a-f &= -14.458 & a-f+f' &= +0.360 \\ -\frac{\sin q}{\sin z} &= +0.160 & \frac{\sin q'}{\sin z'} &= -0.164 \\ \text{cosec } z &= 1.109 & & \\ -\frac{q(q-q') \sin 1'' \sin \Lambda'}{\sin z} &= +0.0006; & \frac{\sin(z'-z) \sin \Lambda'}{\sin z \sin z'} &= -0.0021. \end{aligned}$$

The equation is therefore

$$\begin{aligned} +8''.0 &= 0.505 \delta\omega - 14.458 \delta T + 14.818 \delta T' + 0.360 \delta JT \\ &\quad + 14.963 \delta\alpha + 0.160 \delta\delta \\ &\quad - 14.818 \delta\alpha' - 0.164 \delta\delta' \\ &\quad + 1.109 \delta S + 0.0006 \delta\pi - 0.0021 \delta\varphi; \end{aligned}$$

whence

$$\begin{aligned} \delta\omega &= +15^s.8 + 28.62 \delta T - 29.34 \delta T' - 0.713 \delta JT \\ &\quad - 29.63 \delta\alpha - 0.32 \delta\delta \\ &\quad + 29.34 \delta\alpha' + 0.32 \delta\delta' \\ &\quad - 2.20 \delta S - 0.001 \delta\pi + 0.004 \delta\varphi. \end{aligned}$$

OBSERVATIONS OF EUPHROSYLE.

MADE WITH THE FILAR MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Lieutenant MAURY.—Corrected for refraction.]

EUPHROSYLE.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	(31) — *		(31)'s apparent	
				$A\alpha$	$A\delta$	α	δ
	^h ^m ^s			^m ^s	['] ^{''}	^h ^m ^s	[°] ['] ^{''}
1857, April 24	10 30 21.3	11	A. Z. 301, 59	+0 58.44	+2 22.55	11 42 4.39	-23 37 45.50
25	10 4 30.6	14	" 301, 59	+0 0.55	+1 1.48	11 41 6.50	23 38 25.68
27	10 0 21.3	10	" 301, 59	-1 59.47	-1 33.11	14 39 6.50	23 41 0.41
30	9 48 13.4	11	" 301, 47	+1 22.70	+8 42.18	14 36 5.14	23 44 13.12
May 12	10 8 9.7	4	" 301, 35	+0 34.49	+5 31.73	14 24 12.59	23 50 23.08
22	10 16 14.9	4	" 301, 20	+2 44.86	+2 19.39	14 15 15.65	23 48 48.35
{ 24	9 39 26.0	12	" 301, 20	+1 10.36	+3 0.10	14 13 41.16	23 48 7.77
* { 25	10 7 43.2	4	" 301, 20	+0 22.22	+3 21.06	14 12 53.03	-23 47 46.81

* The right-ascensions of the two last comparisons are observed with the electric apparatus of Mr. Bond, now first introduced in the observatory.

Adopted Mean Places, 1860.0, of Comparison-Stars.

*	Mag.	α			Authority.	δ			Authority.
		^h	^m	^s		[°]	[']	["]	
A. Z. 301, 59	5.6	14	11	11.17	Argelanders Zones.	—23	39	57.30	Y. 2.
" 301, 47	7.8	14	31	50.62	"	23	53	25.90	Y. 1.
" 301, 35	7	14	23	46.13	"	23	56	6.02	Argelanders Zones.
" 301, 20	7	14	12	38.76	"	—23	51	39.78	"

THIRD COMET OF 1857.

A TELESCOPIC COMET of moderate brilliancy was discovered by Dr. KLINKERFUES at Göttingen June 22, and by Mr. DIEX at the Imperial Observatory at Paris June 23.

Mr. KLINKERFUES's observations are

Gött. M. T.		α			δ		
		^h	^m	^s	[°]	[']	["]
1857 June 24	13 30	3	40	2	+41	59	
27	13 30	4	4	48	44	46	

The Paris observations, as communicated by Mr. LE VERRIER, are

Paris M. T.		α			δ			Observer.
		^h	^m	^s	[°]	[']	["]	
1857 June 24	13 7 42.6	3	39	53.86	+41	57	32.1	Yvon Villarcéan.
	13 59 49.3	3	40	10.28	41	59	37.1	Lepissier.

Star of comparison 41 *r Persei*.

From observations of June 23, 24 and 25, Mr. PAPE and Dr. FÖRSTER have computed elements and approximate ephemerides; as also has Dr. KLINKERFUES from his own observations of June 22, 24, 26: all being in the *Astr. Nachr.* 1094.

The elements of Dr. FÖRSTER are as follows:

T	July 18, 1064
π	$249^{\circ} 20' 26''$
Ω	23 18 30
i	59 33 45
$\log q$	9.56451
<i>Retrograde.</i>	

These elements give the following ephemeris for Berlin midnight:

1857	α	δ	$\log I$
June 29	$4^{\text{h}} 26^{\text{m}} 29^{\text{s}}$	$+16^{\circ} 29' 8''$	0.0221
July 3	5 22 54	49 17.0	9.9832
7	6 36 35	49 22.5	9.9516
11	7 52 43	41 59.5	9.9451
15	8 50 17	36 38.8	9.9601

PLANET-CIRCULAR.

A new planet was discovered by Mr. GOLDSCHMIDT in Paris on the 27th June. The discoverer gives the place as follows:

Paris M. T.		45 — *	
1857 June 27	$11^{\text{h}} 45^{\text{m}}$	$1\alpha = -21^{\circ}$	$1\beta = -2.3$

The comparison-star is probably Weisse 454; the mean place for 1825.0 being $16^{\text{h}} 22^{\text{m}} 50^{\text{s}}.30$, $-11^{\circ} 31' 24''$.

CAMBRIDGE, 1857, July 23.

G.

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OBSERVATIONS OF EUPHROSINE, BY JAMES FERGUSON, Esq.

THIRD COMET OF 1857.

PLANET-CIRCULAR: 45th ASTEROID.

THE ASTRONOMICAL JOURNAL.

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NO. 9.

PERIODIC COMET OF D'ARREST (1851 I).

IN N° 964 of the *Astr. Nachr.* (1855, May 30), a sweeping ephemeris was given by Professor OUDEMANS for facilitating the search for the periodic comet discovered by D'ARREST 1851 June 27, and for which the best elements obtained by the discoverer gave a period of 2353 days. With Professor D'ARREST's elements (*Astr. Nachr.* 775), Professor OUDEMANS computed the perturbations by *Jupiter* and *Saturn*, and constructed an ephemeris, by the comparison of which with all accessible observations, he deduced eight normal places.

The solution of the resultant equations of condition furnished some slight corrections to the assumed orbit, which were themselves functions of the mean motion. Those which were found to be the most probable gave the following elements (called by Professor OUDEMANS Elements *C*) :

$$\begin{aligned} T &= 1851, \text{ July } 8.724347 \text{ Berlin M. T.} \\ \pi &= 322^\circ 57' 12''.59 \\ \Omega &= 148^\circ 25' 38''.99 \\ i &= 13^\circ 55' 36''.65 \\ \varphi &= 41^\circ 18' 1''.92 \\ \mu &= 553.25528 \end{aligned} \left. \vphantom{\begin{aligned} T \\ \pi \\ \Omega \\ i \\ \varphi \\ \mu \end{aligned}} \right\} \text{M. Eq. 1851, Jan. 1.}$$

Motion Direct.

By the successive assumptions of a mean daily motion $10'$ and $5'$ greater and $5'$ and $10'$ less than indicated by Elements *C*, Professor OUDEMANS deduced yet other systems which he calls respectively Elements *F*, *D*, *E*, and *G*. The influence of the coefficients of the second power of $d\mu$ being quite sensible in the expressions for the corrections of the elements, these are incorporated in the present results, and an accent appended to the designating letters *D'*, *C'*, *E'*, in

order to distinguish them from corresponding elements formerly published, in which the terms of the second order were disregarded.

The accompanying sweeping ephemeris gives the approximate place, as afforded by each of the five sets of elements for Berlin mean noon of every day from 1857 July 30 to 1858 Jan. 26. Assuming the brilliancy of the comet to be inversely proportional to the product $r^2.F$, the several hypotheses give for the date and amount of maximum brilliancy, and the corresponding mean time, the following values :

Hypothesis.	Date.	Brilliancy.	Culmination.
<i>F</i>	1857 Oct. 23	0.480	4 ^h 4 ^m
<i>D'</i>	Nov. 12	0.313	3 13
<i>C'</i>	Dec. 4	0.230	2 36
<i>E'</i>	Dec. 25	0.186	1 53
<i>G</i>	1858 Jan. 16	0.161	1 7

In 1851, Prof. OUDEMANS states the brilliancy to have been,

at the discovery (1851 June 27)... 1.40
at the maximum (July 6)... 1.44
at the last observation, (Oct. 6)... 0.60 ;

the comet being no longer observable, solely by reason of its faintness.

Professor OUDEMANS rests his hopes of a discovery at the approaching perihelion solely upon the expected efforts of such more southern observatories as are equipped with powerful telescopes, and especially those at Cambridge (Mass.), Washington, Rome, and Madras.

G.

SWEEPING EPHEMERIS FOR THE PERIODIC COMET OF D'ARREST, AT ITS RETURN IN 1857.

BY PROFESSOR J. A. C. OUDEMANS,

DIRECTOR OF THE OBSERVATORY AT UTRECHT.

1857	Hypothesis.	R. A.	Decl.	1857	Hypothesis.	R. A.	Decl.	1857	Hypothesis.	R. A.	Decl.
Sept. 8	<i>F</i>	231° 16	— 8° 29	Sept. 9	<i>F</i>	234° 55	— 8° 47	Sep. 10	<i>F</i>	235° 34	— 9° 5
	<i>D</i>	227 31	6 16		<i>D'</i>	228 6	6 33		<i>D</i>	228 41	6 49
	<i>C'</i>	221 47	4 26		<i>C'</i>	222 18	4 41		<i>C'</i>	222 50	4 56
	<i>E'</i>	216 54	2 58		<i>E'</i>	217 23	3 11		<i>E'</i>	217 52	3 24
	<i>G</i>	212 41	— 1 44		<i>G</i>	213 8	— 1 56		<i>G</i>	213 35	— 2 8

1857	Hypothesis.	R. A.	Decl.	1857	Hypothesis.	R. A.	Decl.	1857	Hypothesis.	R. A.	Dec.
Sep. 11	<i>F</i>	236° 14	— 9° 23	Sep. 21	<i>F</i>	243° 25	— 13° 33	Oct. 1	<i>F</i>	251° 32	— 15° 49
	<i>D</i>	229 16	7 6		<i>D</i>	235 32	9 53		<i>D</i>	242 35	12 39
	<i>C</i>	223 22	5 10		<i>C</i>	228 0	7 38		<i>C</i>	235 15	10 8
	<i>E</i>	218 21	3 37		<i>E</i>	223 27	5 48		<i>E</i>	229 4	8 4
	<i>G</i>	214 2	— 2 19		<i>G</i>	218 43	— 4 19		<i>G</i>	223 45	— 6 23
12	<i>F</i>	236 55	— 9 41	22	<i>F</i>	244 11	— 13 53	2	<i>F</i>	252 23	— 16 8
	<i>D</i>	229 51	7 23		<i>D</i>	236 12	10 10		<i>D</i>	243 20	12 55
	<i>C</i>	223 54	5 21		<i>C</i>	228 35	7 53		<i>C</i>	235 55	10 23
	<i>E</i>	218 50	3 50		<i>E</i>	223 59	6 2		<i>E</i>	229 39	8 18
	<i>G</i>	214 29	— 2 31		<i>G</i>	219 12	— 4 31		<i>G</i>	224 17	— 6 35
13	<i>F</i>	237 36	— 9 59	23	<i>F</i>	244 58	— 13 13	3	<i>F</i>	253 15	— 16 27
	<i>D</i>	230 27	7 39		<i>D</i>	236 52	10 27		<i>D</i>	244 5	13 11
	<i>C</i>	224 26	5 39		<i>C</i>	230 11	8 8		<i>C</i>	236 35	10 38
	<i>E</i>	219 19	4 3		<i>E</i>	224 31	6 16		<i>E</i>	230 15	8 32
	<i>G</i>	214 56	— 2 43		<i>G</i>	219 41	— 4 44		<i>G</i>	224 49	— 6 48
14	<i>F</i>	238 17	— 10 18	24	<i>F</i>	245 46	— 13 32	4	<i>F</i>	254 8	— 16 46
	<i>D</i>	231 4	7 56		<i>D</i>	237 33	10 44		<i>D</i>	244 52	13 27
	<i>C</i>	224 59	5 53		<i>C</i>	230 48	8 23		<i>C</i>	237 16	10 53
	<i>E</i>	219 48	4 16		<i>E</i>	225 4	6 29		<i>E</i>	230 51	8 45
	<i>G</i>	215 24	— 2 55		<i>G</i>	220 11	— 4 56		<i>G</i>	225 21	— 7 0
15	<i>F</i>	238 59	— 10 37	25	<i>F</i>	246 34	— 13 52	5	<i>F</i>	255 1	— 17 4
	<i>D</i>	231 41	8 13		<i>D</i>	238 15	11 1		<i>D</i>	245 39	13 43
	<i>C</i>	225 32	6 8		<i>C</i>	231 24	8 38		<i>C</i>	237 57	11 8
	<i>E</i>	220 18	4 29		<i>E</i>	225 37	6 42		<i>E</i>	231 28	8 59
	<i>G</i>	215 52	— 3 7		<i>G</i>	220 41	— 5 8		<i>G</i>	225 54	— 7 12
16	<i>F</i>	239 42	— 10 56	26	<i>F</i>	247 23	— 14 12	6	<i>F</i>	255 55	— 17 22
	<i>D</i>	232 18	8 29		<i>D</i>	238 57	11 17		<i>D</i>	246 26	13 59
	<i>C</i>	226 6	6 23		<i>C</i>	232 1	8 53		<i>C</i>	238 39	11 23
	<i>E</i>	220 49	4 42		<i>E</i>	226 11	6 56		<i>E</i>	232 5	9 12
	<i>G</i>	216 20	— 3 19		<i>G</i>	221 11	— 5 20		<i>G</i>	226 27	— 7 24
17	<i>F</i>	240 25	— 11 16	27	<i>F</i>	248 12	— 14 31	7	<i>F</i>	256 50	— 17 40
	<i>D</i>	232 56	8 46		<i>D</i>	239 39	11 33		<i>D</i>	247 13	14 15
	<i>C</i>	226 40	6 38		<i>C</i>	232 39	9 8		<i>C</i>	239 21	11 37
	<i>E</i>	221 20	4 55		<i>E</i>	226 45	7 10		<i>E</i>	232 42	9 26
	<i>G</i>	216 48	— 3 31		<i>G</i>	221 41	— 5 33		<i>G</i>	227 0	— 7 37
18	<i>F</i>	241 9	— 11 35	28	<i>F</i>	249 1	— 14 51	8	<i>F</i>	257 46	— 17 58
	<i>D</i>	233 34	9 2		<i>D</i>	240 22	11 50		<i>D</i>	248 1	14 31
	<i>C</i>	227 14	6 53		<i>C</i>	233 18	9 23		<i>C</i>	240 3	11 51
	<i>E</i>	221 51	5 9		<i>E</i>	227 19	7 21		<i>E</i>	233 20	9 39
	<i>G</i>	217 16	— 3 43		<i>G</i>	222 12	— 5 46		<i>G</i>	227 34	— 7 50
19	<i>F</i>	241 54	— 11 51	29	<i>F</i>	249 51	— 15 10	9	<i>F</i>	258 43	— 18 15
	<i>D</i>	234 13	9 19		<i>D</i>	241 6	12 7		<i>D</i>	248 50	14 47
	<i>C</i>	227 49	7 8		<i>C</i>	233 57	9 38		<i>C</i>	240 46	12 5
	<i>E</i>	222 23	5 22		<i>E</i>	227 54	7 37		<i>E</i>	233 58	9 52
	<i>G</i>	217 45	— 3 55		<i>G</i>	222 43	— 5 58		<i>G</i>	228 8	— 8 2
20	<i>F</i>	242 39	— 13 13	30	<i>F</i>	250 41	— 15 30	10	<i>F</i>	259 40	— 18 32
	<i>D</i>	234 52	9 36		<i>D</i>	241 50	12 23		<i>D</i>	249 40	15 3
	<i>C</i>	227 24	7 23		<i>C</i>	234 36	9 53		<i>C</i>	241 29	12 20
	<i>E</i>	222 55	5 35		<i>E</i>	228 29	7 50		<i>E</i>	234 37	10 6
	<i>G</i>	218 14	— 4 7		<i>G</i>	223 14	— 6 10		<i>G</i>	228 43	— 8 14

1857	Hypothesis.	R. A.	Decl.	1857	Hypothesis.	R. A.	Decl.	1857	Hypothesis.	R. A.	Decl.
Oct. 11	<i>F</i>	260° 38	—18° 49	Oct. 21	<i>F</i>	270° 40	—21° 23	Oct. 31	<i>F</i>	281° 35	—23° 16
	<i>D</i>	250 29	15 19		<i>D</i>	259 11	17 48		<i>D</i>	268 45	19 53
	<i>C</i>	242 13	12 35		<i>C</i>	249 55	14 54		<i>C</i>	258 23	16 58
	<i>E</i>	235 16	10 19		<i>E</i>	242 6	12 29		<i>E</i>	249 37	14 32
	<i>G</i>	229 18	— 8 26		<i>G</i>	235 26	—10 28		<i>G</i>	242 10	—12 23
12	<i>F</i>	261 36	—19 6	22	<i>F</i>	271 43	—21 37	Nov. 1	<i>F</i>	282 43	—23 24
	<i>D</i>	251 19	15 35		<i>D</i>	260 6	18 3		<i>D</i>	269 15	20 4
	<i>C</i>	242 57	12 49		<i>C</i>	250 44	15 7		<i>C</i>	259 16	17 10
	<i>E</i>	235 56	10 33		<i>E</i>	242 49	12 41		<i>E</i>	250 24	14 44
	<i>G</i>	229 53	— 8 39		<i>G</i>	236 5	—10 40		<i>G</i>	242 53	—12 34
13	<i>F</i>	262 35	—19 22	23	<i>F</i>	272 46	—21 51	2	<i>F</i>	283 52	—23 31
	<i>D</i>	252 9	15 51		<i>D</i>	261 1	18 17		<i>D</i>	270 46	20 15
	<i>C</i>	243 41	13 3		<i>C</i>	251 33	15 20		<i>C</i>	260 9	17 21
	<i>E</i>	236 36	10 46		<i>E</i>	243 32	12 54		<i>E</i>	251 12	14 55
	<i>G</i>	230 28	— 8 52		<i>G</i>	236 14	—10 51		<i>G</i>	243 36	—12 45
14	<i>F</i>	263 34	—19 38	24	<i>F</i>	273 50	—22 3	3	<i>F</i>	285 1	—23 38
	<i>D</i>	253 0	16 6		<i>D</i>	261 57	18 30		<i>D</i>	271 47	20 25
	<i>C</i>	244 26	13 17		<i>C</i>	252 23	15 33		<i>C</i>	261 3	17 32
	<i>E</i>	237 16	10 59		<i>E</i>	241 16	13 6		<i>E</i>	252 1	15 6
	<i>G</i>	231 4	— 9 4		<i>G</i>	237 24	—11 3		<i>G</i>	244 19	—12 56
15	<i>F</i>	264 34	—19 54	25	<i>F</i>	274 55	—22 15	4	<i>F</i>	286 10	—23 41
	<i>D</i>	253 52	16 21		<i>D</i>	262 54	18 42		<i>D</i>	272 49	20 35
	<i>C</i>	245 12	13 31		<i>C</i>	253 13	15 45		<i>C</i>	261 57	17 43
	<i>E</i>	237 57	11 12		<i>E</i>	245 1	13 19		<i>E</i>	252 50	15 17
	<i>G</i>	231 40	— 9 16		<i>G</i>	238 4	—11 15		<i>G</i>	245 3	—13 7
16	<i>F</i>	265 34	—20 10	26	<i>F</i>	276 0	—22 26	5	<i>F</i>	287 19	—23 50
	<i>D</i>	254 41	16 36		<i>D</i>	263 51	18 55		<i>D</i>	273 51	20 44
	<i>C</i>	245 58	13 45		<i>C</i>	254 3	15 58		<i>C</i>	262 52	17 53
	<i>E</i>	238 38	11 25		<i>E</i>	245 46	13 32		<i>E</i>	253 39	15 28
	<i>G</i>	232 17	— 9 28		<i>G</i>	238 44	—11 26		<i>G</i>	245 47	—13 18
17	<i>F</i>	266 35	—20 26	27	<i>F</i>	277 6	—22 37	6	<i>F</i>	288 28	—23 56
	<i>D</i>	255 36	16 51		<i>D</i>	264 18	19 7		<i>D</i>	274 53	20 53
	<i>C</i>	246 44	13 59		<i>C</i>	254 54	16 10		<i>C</i>	263 48	18 3
	<i>E</i>	239 19	11 38		<i>E</i>	246 31	13 44		<i>E</i>	254 28	15 39
	<i>G</i>	232 54	— 9 40		<i>G</i>	239 24	—11 37		<i>G</i>	246 31	—13 29
18	<i>F</i>	267 36	—20 41	28	<i>F</i>	278 13	—22 48	7	<i>F</i>	289 38	—24 1
	<i>D</i>	256 29	17 6		<i>D</i>	265 46	19 19		<i>D</i>	275 55	21 2
	<i>C</i>	247 31	14 13		<i>C</i>	255 45	16 22		<i>C</i>	264 43	18 14
	<i>E</i>	240 0	11 51		<i>E</i>	247 16	13 56		<i>E</i>	255 17	15 50
	<i>G</i>	233 31	— 9 52		<i>G</i>	240 5	—11 48		<i>G</i>	247 15	—13 39
19	<i>F</i>	268 37	—20 55	29	<i>F</i>	279 20	—22 58	8	<i>F</i>	290 48	—24 6
	<i>D</i>	257 23	17 20		<i>D</i>	266 45	19 31		<i>D</i>	276 58	21 10
	<i>C</i>	248 19	14 27		<i>C</i>	256 37	16 34		<i>C</i>	265 39	18 24
	<i>E</i>	240 42	12 4		<i>E</i>	248 3	14 8		<i>E</i>	256 7	16 1
	<i>G</i>	234 9	—10 4		<i>G</i>	240 46	—12 0		<i>G</i>	248 0	—13 50
20	<i>F</i>	269 38	—21 9	30	<i>F</i>	280 27	—23 7	9	<i>F</i>	291 59	—24 10
	<i>D</i>	258 17	17 34		<i>D</i>	267 45	19 42		<i>D</i>	278 0	21 18
	<i>C</i>	249 7	14 41		<i>C</i>	257 30	16 46		<i>C</i>	266 36	18 34
	<i>E</i>	241 24	12 17		<i>E</i>	248 50	14 20		<i>E</i>	256 58	16 42
	<i>G</i>	234 47	—10 16		<i>G</i>	241 28	—12 12		<i>G</i>	248 45	—14 0

1857	Hypothesis.	R. A.	Decl.	1857	Hypothesis.	R. A.	Decl.	1857	Hypothesis.	R. A.	Decl.
Nov. 10	<i>F</i>	293° 10	—24° 13	Nov. 20	<i>F</i>	304° 52	—24° 14	Nov. 30	<i>F</i>	316° 17	—23° 19
	<i>D</i>	279 1	21 26		<i>D</i>	289 57	22 15		<i>D</i>	301 9	22 17
	<i>C</i>	267 33	18 44		<i>C</i>	277 23	20 2		<i>C</i>	287 50	20 45
	<i>E</i>	257 49	16 22		<i>E</i>	266 40	17 52		<i>E</i>	276 12	18 58
	<i>G</i>	249 30	—14 10		<i>G</i>	247 25	—15 45		<i>G</i>	265 59	—17 4
11	<i>F</i>	291 21	—24 16	21	<i>F</i>	306 1	—24 11	Dec. 1	<i>F</i>	317 24	—23 10
	<i>D</i>	280 8	21 31		<i>D</i>	291 4	22 18		<i>D</i>	302 16	22 14
	<i>C</i>	268 30	18 53		<i>C</i>	278 24	20 8		<i>C</i>	288 54	20 47
	<i>E</i>	258 40	16 32		<i>E</i>	265 35	18 0		<i>E</i>	277 11	19 3
	<i>G</i>	250 15	—14 20		<i>G</i>	248 15	—15 51		<i>G</i>	266 52	—17 11
12	<i>F</i>	295 32	—24 18	22	<i>F</i>	307 10	—24 8	2	<i>F</i>	318 31	—23 0
	<i>D</i>	281 12	21 41		<i>D</i>	292 11	22 20		<i>D</i>	303 23	22 11
	<i>C</i>	269 27	19 2		<i>C</i>	279 26	20 14		<i>C</i>	289 59	20 49
	<i>E</i>	259 31	16 42		<i>E</i>	268 31	18 8		<i>E</i>	278 10	19 8
	<i>G</i>	251 1	—14 30		<i>G</i>	259 5	—16 3		<i>G</i>	267 45	—17 18
13	<i>F</i>	296 42	—24 20	23	<i>F</i>	308 19	—24 4	3	<i>F</i>	319 38	—22 50
	<i>D</i>	282 17	21 46		<i>D</i>	293 18	22 21		<i>D</i>	304 30	22 7
	<i>C</i>	270 25	19 11		<i>C</i>	280 28	20 19		<i>C</i>	291 3	20 50
	<i>E</i>	260 23	16 52		<i>E</i>	269 27	18 15		<i>E</i>	279 9	19 12
	<i>G</i>	251 48	—14 40		<i>G</i>	259 56	—16 11		<i>G</i>	268 39	—17 24
14	<i>F</i>	297 53	—24 21	24	<i>F</i>	309 28	—23 59	4	<i>F</i>	320 44	—22 40
	<i>D</i>	283 22	21 52		<i>D</i>	294 25	22 21		<i>D</i>	305 37	22 2
	<i>C</i>	271 24	19 19		<i>C</i>	281 30	20 24		<i>C</i>	292 8	20 50
	<i>E</i>	261 16	17 1		<i>E</i>	270 24	18 22		<i>E</i>	280 9	19 16
	<i>G</i>	252 35	—14 50		<i>G</i>	260 47	—16 19		<i>G</i>	269 33	—17 30
15	<i>F</i>	299 3	—24 20	25	<i>F</i>	310 37	—23 53	5	<i>F</i>	321 50	—22 30
	<i>D</i>	284 27	21 57		<i>D</i>	295 32	22 22		<i>D</i>	306 44	21 58
	<i>C</i>	272 23	19 27		<i>C</i>	282 33	20 28		<i>C</i>	293 13	20 51
	<i>E</i>	262 9	17 10		<i>E</i>	271 24	18 28		<i>E</i>	281 9	19 20
	<i>G</i>	253 22	—15 0		<i>G</i>	261 38	—16 27		<i>G</i>	270 28	—17 36
16	<i>F</i>	300 13	—24 20	26	<i>F</i>	311 46	—23 47	6	<i>F</i>	322 55	—22 19
	<i>D</i>	285 32	22 2		<i>D</i>	296 39	22 22		<i>D</i>	307 51	21 54
	<i>C</i>	273 22	19 35		<i>C</i>	283 36	20 32		<i>C</i>	294 18	20 51
	<i>E</i>	263 2	17 19		<i>E</i>	272 18	18 34		<i>E</i>	282 9	19 23
	<i>G</i>	254 9	—15 9		<i>G</i>	262 30	—16 35		<i>G</i>	271 23	—17 41
17	<i>F</i>	301 23	—21 20	27	<i>F</i>	312 54	—23 41	7	<i>F</i>	324 0	—22 8
	<i>D</i>	286 38	22 7		<i>D</i>	297 47	22 22		<i>D</i>	308 58	21 49
	<i>C</i>	271 21	19 42		<i>C</i>	284 38	20 36		<i>C</i>	295 23	20 51
	<i>E</i>	263 55	17 28		<i>E</i>	273 16	18 41		<i>E</i>	283 10	19 26
	<i>G</i>	254 57	—15 18		<i>G</i>	263 22	—16 43		<i>G</i>	272 18	—17 46
18	<i>F</i>	302 33	—21 19	28	<i>F</i>	314 2	—23 34	8	<i>F</i>	325 4	—21 57
	<i>D</i>	287 44	22 10		<i>D</i>	298 54	22 21		<i>D</i>	310 4	21 43
	<i>C</i>	275 21	19 49		<i>C</i>	285 42	20 39		<i>C</i>	296 28	20 50
	<i>E</i>	264 50	17 36		<i>E</i>	274 14	18 47		<i>E</i>	284 11	19 28
	<i>G</i>	245 46	—15 27		<i>G</i>	264 14	—16 50		<i>G</i>	273 14	—17 51
19	<i>F</i>	303 43	—21 17	29	<i>F</i>	315 10	—23 27	9	<i>F</i>	326 8	—21 45
	<i>D</i>	288 50	22 13		<i>D</i>	300 2	22 19		<i>D</i>	311 11	21 37
	<i>C</i>	276 22	19 56		<i>C</i>	286 46	20 42		<i>C</i>	297 33	20 48
	<i>E</i>	265 45	17 44		<i>E</i>	275 13	18 53		<i>E</i>	285 12	19 30
	<i>G</i>	246 35	—15 36		<i>G</i>	265 6	—16 57		<i>G</i>	274 10	—17 56

1857	Hypothesis.	R. A.	Decl.	1857	Hypothesis.	R. A.	Decl.	1857	Hypothesis.	R. A.	Decl.
Dec. 10	<i>F</i>	327° 12	—21° 33	Dec. 20	<i>F</i>	335° 23	—19° 10	Dec. 30	<i>F</i>	346° 43	—16° 25
	<i>D</i>	312 17	21 30		<i>D</i>	323 8	20 0		<i>D</i>	333 26	17 53
	<i>C</i>	298 38	20 46		<i>C</i>	309 28	19 59		<i>C</i>	320 9	18 35
	<i>E</i>	286 14	19 32		<i>E</i>	296 37	19 28		<i>E</i>	307 12	18 45
	<i>G</i>	275 7	—18 0		<i>G</i>	284 49	—18 25		<i>G</i>	294 51	—18 19
11	<i>F</i>	328 15	—21 21	21	<i>F</i>	334 21	—18 54	31	<i>F</i>	347 36	—16 8
	<i>D</i>	313 23	21 23		<i>D</i>	324 12	19 49		<i>D</i>	334 25	17 39
	<i>C</i>	299 43	20 43		<i>C</i>	310 34	19 52		<i>C</i>	321 12	18 25
	<i>E</i>	287 15	19 33		<i>E</i>	297 40	19 25		<i>E</i>	308 15	18 39
	<i>G</i>	276 4	—18 4		<i>G</i>	285 48	—18 26		<i>G</i>	295 53	—18 17
12	<i>F</i>	329 18	—21 8	22	<i>F</i>	339 18	—18 37	1858 Jan. 1	<i>F</i>	348 29	—15 51
	<i>D</i>	314 29	21 16		<i>D</i>	325 16	19 37		<i>D</i>	335 24	17 24
	<i>C</i>	300 48	20 40		<i>C</i>	311 40	19 45		<i>C</i>	322 15	18 15
	<i>E</i>	288 17	19 34		<i>E</i>	298 41	19 22		<i>E</i>	309 19	18 32
	<i>G</i>	277 1	—18 8		<i>G</i>	286 47	—18 27		<i>G</i>	296 55	—18 14
13	<i>F</i>	330 20	—20 55	23	<i>F</i>	340 15	—18 21	2	<i>F</i>	349 21	—15 33
	<i>D</i>	315 34	21 7		<i>D</i>	326 19	19 25		<i>D</i>	336 22	17 9
	<i>C</i>	301 53	20 36		<i>C</i>	312 45	19 37		<i>C</i>	323 17	18 4
	<i>E</i>	289 19	19 34		<i>E</i>	299 47	19 19		<i>E</i>	310 23	18 25
	<i>G</i>	277 59	—18 11		<i>G</i>	287 47	—18 27		<i>G</i>	297 56	—18 10
14	<i>F</i>	331 22	—20 41	24	<i>F</i>	341 12	—18 4	3	<i>F</i>	350 13	—15 16
	<i>D</i>	316 40	20 59		<i>D</i>	327 21	19 13		<i>D</i>	337 20	16 54
	<i>C</i>	302 58	20 32		<i>C</i>	313 49	19 29		<i>C</i>	324 19	17 53
	<i>E</i>	290 21	19 31		<i>E</i>	300 50	19 15		<i>E</i>	311 26	18 18
	<i>G</i>	278 57	—18 14		<i>G</i>	288 47	—18 27		<i>G</i>	298 58	—18 6
15	<i>F</i>	332 23	—20 27	25	<i>F</i>	342 8	—17 18	4	<i>F</i>	351 5	—14 58
	<i>D</i>	317 15	20 50		<i>D</i>	328 23	19 0		<i>D</i>	338 17	16 38
	<i>C</i>	304 3	20 28		<i>C</i>	314 53	19 21		<i>C</i>	325 21	17 42
	<i>E</i>	291 23	19 34		<i>E</i>	301 53	19 11		<i>E</i>	312 29	18 10
	<i>G</i>	279 55	—18 17		<i>G</i>	289 47	—18 27		<i>G</i>	300 0	—18 2
16	<i>F</i>	333 24	—20 12	26	<i>F</i>	344 4	—17 31	5	<i>F</i>	351 56	—14 40
	<i>D</i>	318 50	20 41		<i>D</i>	329 25	18 47		<i>D</i>	339 14	16 23
	<i>C</i>	305 8	20 24		<i>C</i>	315 57	19 13		<i>C</i>	326 23	17 30
	<i>E</i>	292 25	19 34		<i>E</i>	302 57	19 7		<i>E</i>	313 32	18 2
	<i>G</i>	280 53	—18 19		<i>G</i>	290 47	—18 26		<i>G</i>	301 2	—17 58
17	<i>F</i>	334 25	—19 57	27	<i>F</i>	344 0	—17 15	6	<i>F</i>	352 47	—14 22
	<i>D</i>	319 55	20 32		<i>D</i>	330 26	18 34		<i>D</i>	340 12	16 7
	<i>C</i>	306 13	20 19		<i>C</i>	317 0	19 4		<i>C</i>	327 24	17 18
	<i>E</i>	293 28	19 33		<i>E</i>	304 1	19 2		<i>E</i>	314 34	17 51
	<i>G</i>	281 51	—18 21		<i>G</i>	291 48	—18 25		<i>G</i>	302 4	—17 54
18	<i>F</i>	335 25	—19 42	28	<i>F</i>	344 55	—16 58	7	<i>F</i>	353 37	—14 4
	<i>D</i>	321 0	20 22		<i>D</i>	331 26	18 21		<i>D</i>	341 8	15 51
	<i>C</i>	307 18	20 13		<i>C</i>	318 3	18 55		<i>C</i>	328 25	17 5
	<i>E</i>	294 31	19 32		<i>E</i>	305 5	18 57		<i>E</i>	315 37	17 45
	<i>G</i>	282 50	—18 23		<i>G</i>	292 49	—18 23		<i>G</i>	303 6	—17 49
19	<i>F</i>	336 24	—19 26	29	<i>F</i>	345 49	—16 42	8	<i>F</i>	354 27	—13 45
	<i>D</i>	322 4	20 11		<i>D</i>	332 26	18 7		<i>D</i>	342 3	15 35
	<i>C</i>	308 23	20 6		<i>C</i>	319 6	18 45		<i>C</i>	329 26	16 52
	<i>E</i>	295 34	19 30		<i>E</i>	306 8	18 51		<i>E</i>	316 40	17 36
	<i>G</i>	283 49	—18 24		<i>G</i>	293 50	—18 21		<i>G</i>	304 9	—17 44

1858	Hypothesis.	R. A.	Decl.	1858	Hypothesis.	R. A.	Decl.	1858	Hypothesis.	R. A.	Decl.
Jan. 9	<i>F</i>	355° 16	—13° 27	Jan. 15	<i>F</i>	0° 1	—11° 38	Jan. 21	<i>F</i>	4° 32	—9° 50
	<i>D</i>	312 59	15 18		<i>D</i>	318 28	13 37		<i>D</i>	353 40	11 56
	<i>C</i>	330 26	16 39		<i>C</i>	334 21	15 16		<i>C</i>	312 5	13 17
	<i>E</i>	317 42	17 27		<i>E</i>	323 55	16 25		<i>E</i>	330 1	15 12
	<i>G</i>	305 11	—17 28		<i>G</i>	311 23	—16 58		<i>G</i>	317 31	—16 5
10	<i>F</i>	356 5	—13 9	16	<i>F</i>	0 47	—11 20	22	<i>F</i>	5 16	—9 33
	<i>D</i>	313 55	15 2		<i>D</i>	319 21	13 20		<i>D</i>	354 30	11 38
	<i>C</i>	331 26	16 26		<i>C</i>	337 19	15 2		<i>C</i>	313 1	13 31
	<i>E</i>	318 11	17 18		<i>E</i>	324 57	16 11		<i>E</i>	331 1	14 59
	<i>G</i>	306 13	—17 32		<i>G</i>	312 25	—16 50		<i>G</i>	318 36	—15 55
11	<i>F</i>	356 53	—12 50	17	<i>F</i>	1 33	—11 2	23	<i>F</i>	6 0	—9 15
	<i>D</i>	341 51	14 45		<i>D</i>	350 14	13 4		<i>D</i>	355 20	11 21
	<i>C</i>	332 26	16 12		<i>C</i>	338 16	14 47		<i>C</i>	343 56	13 15
	<i>E</i>	319 47	17 8		<i>E</i>	325 58	16 2		<i>E</i>	332 0	14 15
	<i>G</i>	307 15	—17 26		<i>G</i>	313 27	—16 41		<i>G</i>	319 38	—15 41
12	<i>F</i>	357 41	—12 32	18	<i>F</i>	2 18	—10 41	24	<i>F</i>	6 41	—8 58
	<i>D</i>	345 46	11 28		<i>D</i>	351 6	12 47		<i>D</i>	356 9	11 4
	<i>C</i>	333 25	15 58		<i>C</i>	339 13	11 32		<i>C</i>	344 52	12 59
	<i>E</i>	320 49	16 58		<i>E</i>	326 59	15 50		<i>E</i>	332 59	11 31
	<i>G</i>	308 17	—17 19		<i>G</i>	311 29	—16 32		<i>G</i>	320 40	—15 33
13	<i>F</i>	358 28	—12 14	19	<i>F</i>	3 3	—10 26	25	<i>F</i>	7 27	—8 41
	<i>D</i>	346 10	14 11		<i>D</i>	351 58	12 30		<i>D</i>	356 59	10 47
	<i>C</i>	331 21	15 44		<i>C</i>	340 11	14 17		<i>C</i>	345 48	12 43
	<i>E</i>	321 51	16 47		<i>E</i>	328 0	15 37		<i>E</i>	333 58	14 17
	<i>G</i>	309 19	—17 12		<i>G</i>	315 31	—16 20		<i>G</i>	321 41	—15 22
14	<i>F</i>	359 15	—11 56	20	<i>F</i>	3 48	—10 8	26	<i>F</i>	8 10	—8 24
	<i>D</i>	317 34	13 51		<i>D</i>	352 49	12 13		<i>D</i>	357 49	10 30
	<i>C</i>	333 23	15 30		<i>C</i>	311 8	11 2		<i>C</i>	346 43	12 27
	<i>E</i>	322 53	16 36		<i>E</i>	329 1	15 26		<i>E</i>	334 57	11 2
	<i>G</i>	310 21	—17 5		<i>G</i>	316 33	—16 14		<i>G</i>	322 42	—15 11

FORTY-FOURTH AND FORTY-FIFTH ASTEROIDS.

The following observations from the *Astronomische Nachrichten* embrace the dates of all that have come to hand :

Date.	Place.	M. T. of Place.	$\odot \alpha$	$\odot \delta$
		^h ^m ^s	^h ^m ^s	[°] ['] ["]
June 8	Vienna	10 33 5.7	15 7 13.51	—
9	"	10 15 21.7	15 6 36.79	—11 52 42.8
12	"	11 2 46.9	15 4 52.92	11 51 11.0
13	Bilk	10 56 18.5	15 4 20.68	11 50 53.0
15	Bonn	10 11 11	15 3 23.78	11 50 45.5
16	"	11 46 19	15 2 55.16	11 50 19.9
"	Kremsm.	9 22 19.22	15 2 30.43	11 38 28.88
17	Bonn	11 7 38.5	15 2 30.35	11 51 6.5
18	"	11 1 6.7	15 2 6.56	11 51 27.0
"	Kremsm.	9 3 34.77	15 1 37.66	11 37 49.12
19	Bonn	11 36 8.8	15 1 43.78	11 51 57.6
22	"	12 13 10	15 0 46.99	11 51 14.3
23	"	11 25 11	15 0 31.51	11 55 7.0
28	Berlin	12 53 22	15 0 46.33	—11 51 10.8

Cambridge, 1857 August 8.

The Bonn observations of June 15 – 19 are by Mr. CARL STRUVE, son and brother of the eminent astronomers of Pulkowa.

Of the forty-fifth asteroid, besides the two comparisons with Weisse XVI. 454, made by Mr. GOLDSCHMIDT, viz :

	Paris M. T.	$\odot \alpha$	$\odot \delta$
1857 June 27	11 ^h 45 ^m 0 ^s	$\alpha = -21^s$	$\delta = -2 18$
28	10 4 0	—53.40	—4 48.

Dr. FÖRSTER has published two made at Berlin (the first one being approximate), and Professor LITTROW one at Vienna.

	Berlin M. T.	$\odot \alpha$	$\odot \delta$
June 30	13 ^h 30 ^m 0 ^s	245° 41 0	—11° 47 30
July 2	11 36 26	245 27 26.5	11 52 31.7
	Vienna M. T.		
July 2	11 ^h 16 ^m 0 ^s	16 18 19.78	—12 32 47.0

G.

FROM A LETTER OF JAMES C. WATSON, ESQ., TO THE EDITOR.

Ann-Arbor, 1857, July 27.

I HAVE computed the following elements of *Ariadne* 43 from the observations at Oxford April 16 and May 2, and at Bilk May 18 :

$$\begin{aligned}
 \text{Epoch} &= 1857 \text{ May } 18.0 \text{ Washington M. T.} \\
 M &= 316^{\circ} 3' 35.3 \\
 \pi &= 277' 15'' 50.5 \\
 Q &= 264' 28'' 11.1 \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \text{Mean equinox 1857.0} \\
 i &= 3' 28'' 3.1 \\
 c &= 9' 32'' 27.8 \\
 \log a &= 0.343146 \\
 \log \mu &= 3.035288 \\
 \mu &= 1084.645
 \end{aligned}$$

J. C. WATSON.

COMET 1857 IV.

BY DR. C. H. F. PETERS.

THIS Comet was found (as astronomers have been notified by Circular) on the evening of July 25, at the Dudley Observatory. If the priority of discovery remains to me, I propose to call it the *Olcott Comet*, after the very beloved and esteemed name of the distinguished citizen who is identified with the history of the erection of this observatory.

The observations, which I have thus far succeeded in ob-

taining, are the following, made with a circular micrometer of the Clark comet-seeker, and reduced with due regard to the comet's motion during its transit through the ring, corrected for refraction, but not for parallax. They are as good as the instrument and circumstances permitted; the inner limb of the micrometer only being available, and the comet very faint, showing no sort of nucleus and an ill-defined outline.

1857 Albany M. T.	α (☾—*)	δ (☾—*)	Comp.	$\angle \alpha$	$\angle \delta$
^h ^m ^s	^m ^s	['] ^{''}		^h ^m ^s	[°] ['] ^{''}
July 25 11 50 20.9	+ 2 44.66	—21 21.0	10	3 33 43.60	+59 8 52.9
26 12 47 43.9	— 20.11	+ 6 21.3	9	3 46 26.02	58 18 26.1
27 12 31 51.8	— 7 22.62	— 5 6.1	11	3 57 58.09	57 21 48.2
29 13 11 46.3	+ 4 57.82	+ 4 14.0	9	4 20 13.84	55 22 53.2

Mean Places 1857.0 of Comparison-Stars.

Day.	α	δ	Authority.
^h ^m ^s	[°] ['] ^{''}		
July 25 3 30 57.67	+59 30 13.4	Oeltzen Arg. 3999—4000 and Radcliffe Obs.	
26 3 46 44.84	58 12 3.8	O. Arg. 4278	
27 4 5 19.43	57 29 53.0	O. Arg. 4609 and Radcl. Obs.	
29 4 15 11.66	55 18 37.3	O. Arg. 4779	

From observations July 25, 27, 29, the following parabolic elements are derived, the small corrections for parallax and aberration having been applied :

$$\begin{aligned}
 T &= 1857 \text{ Aug. } 25.07597 \text{ Greenwich M. T.} \\
 \pi &= 25^{\circ} 17' 58.3 \\
 Q &= 199' 13'' 31.7 \\
 i &= 35' 27'' 12.6 \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \text{Mean Eq. and Obl. 1857.0} \\
 \log q &= 9.864042
 \end{aligned}$$

Motion Direct.

These elements, compared with the observations, leave the following errors :

C.—O.

$$\begin{array}{ccc}
 \text{July 25} & \overset{\alpha}{-0.1} & \overset{\delta}{+ 0.1} \\
 26 & -7.5 & -24.7 \\
 27 & -5.9 & +21.8 \\
 29 & -0.6 & - 1.0;
 \end{array}$$

and they seem, therefore, pretty near the truth, so that I have delayed any further correction until later observations shall be obtained.

The equatorial coördinates become

$$\begin{aligned}
 x &= (9.85596) \sin \{111^{\circ} 56.4 + v\} \sec^2 \frac{1}{2} v \\
 y &= (9.85704) \sin \{ 23' 57.6 + v\} \sec^2 \frac{1}{2} v \\
 z &= (9.28112) \sin \{155' 56.7 + v\} \sec^2 \frac{1}{2} v;
 \end{aligned}$$

by means of which expression the annexed ephemeris has been computed. It will be seen that the comet passes from the constellation of *Camelopardalus*, where it was first observed, into *Auriga*, *Gemini*, *Canis minor*, *Monoceros* and *Hydra*. During its whole course it will be visible only in the morning, before sunrise; its nearest elongation from the sun (about 3 hours) happening on the 8 or 9 September. The comet passed its nearest distance to the earth on the 1 August; but as the comet and the earth move in the same direction, this distance does not increase very rapidly, and the visibility therefore may continue for a considerable time, especially if, as may be expected, the comet is to develop a greater brilliancy on and after its neighborhood to the perihelion on the 25 August.

EPHEMERIS OF THE OLCOTT COMET,

For Washington Mean Midnight.

Wash. M. T.	ℓa	$\ell \delta$	$\log \Delta$
Aug. 1.5	4 ^h 49 ^m 36 ^s	+51° 57'	9.82252
3.5	5 7 15	49 23	
5.5	5 23 21	46 40	9.82478
7.5	5 38 6	43 49	
9.5	5 51 39	40 55	9.83260

DUDLEY OBSERVATORY, Albany, 1857 Aug. 12.

Wash. M. T.	ℓa	$\ell \delta$	$\log \Delta$
Aug. 11.5	6 ^h 4 ^m 8 ^s	+37° 58'	
13.5	6 15 44	35 0	9.84573
15.5	6 26 35	32 4	
17.5	6 36 45	29 11	9.86353
19.5	6 46 23	26 22	
21.5	6 55 33	23 38	9.88501
23.5	7 4 18	20 59	
25.5	7 12 42	18 28	9.90906
27.5	7 20 18	16 3	
29.5	7 28 36	13 45	9.93452
31.5	7 36 10	11 35	
Sept. 2.5	7 43 31	9 31	9.96059
4.5	7 50 39	7 33	
6.5	7 57 31	5 43	9.98610
8.5	8 4 18	3 58	
10.5	8 10 50	2 19	0.01056
12.5	8 17 11	+ 0 46	
14.5	8 23 21	- 0 43	0.03395
16.5	8 29 20	2 6	
18.5	8 35 8	3 26	0.05588
20.5	8 56 31	8 6	0.09519
Oct. 4.5	9 15 21	11 59	0.12861
12.5	9 31 38	15 18	0.15658
20.5	9 45 33	18 12	0.17980
28.5	9 57 10	-20 46	0.19872

C. H. F. PETERS.

ELEMENTS AND EPHEMERIS OF THE FOURTH COMET OF 1857.

COMPUTED BY JAMES C. WATSON.

THE elements were computed from the observations at Albany July 27, and the two following positions :

1857	Ann-Arbor M. T.	ℓa	$\ell \delta$	Comp.
Aug. 3	15 ^h 21 ^m 43 ^s .9	5 ^h 7 ^m 51 ^s .68	+49° 16' 18".4	12
10	15 05 46.2	5 56 47.51	+39 42 58.9	9

They are :

ELEMENTS OF COMET 1857 IV.

$T =$	1857 August 23.2599	Washington M. T.
$\pi =$	20° 53' 36"	} Mean Equinox 1857.0
$\Omega =$	201 29 2	
$i =$	32 10 11	
$\log q =$	9.874873	

Motion Direct.

The middle place is represented in the following manner :

$$\text{Comp.} - \text{Obs.} \\ \Delta a \cos \delta = +45'; \quad \Delta \delta = -2' 42''$$

These elements give the following

EPHEMERIS FOR WASHINGTON MEAN MIDNIGHT.

1857	ℓa	$\ell \delta$	$\log \Delta$
August 12	6 ^h 7 ^m 26 ^s	+37° 8.3'	9.9005
16	6 28 12	31 41.0	9.8564
20	6 46 36	26 28.7	9.8782
24	7 3 11	21 37.1	9.9020
28	7 18 34	17 9.1	9.9266
Sept. 1	7 32 50	13 5.3	9.9514
5	7 45 56	8 24.1	9.9762

Ann-Arbor, 1857 August 12.

JAMES C. WATSON.

CORRIGENDA.

No. 104, Date, for June read July.

102, p. 42, Col. 1, l. -3, read $\phi = 12^\circ 32' 46''.29$.

43, The Ephemeris is for Mean Berlin Midnight.

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NO. 10.

ON THE CORRECTION OF THE ELEMENTS OF CERES, WITH EPHEMERIS FOR THE OPPOSITION OF 1858.

BY ERNEST SCHUBERT.

[Report to Prof. WINLOCK, Superintendent American Ephemeris.]

I. ELEMENTS.

IN the correction of the elements of *Ceres* made in 1853, I only took into account the perturbations by *Jupiter* as computed by Professor ENCKE and Professor WOLFERS. The corrected elements, published in N° 69 of the *Astr. Journal*, are therefore not yet freed from the effect of the perturbations by *Saturn*. Besides this, an error occurred in copying; the perturbations in φ being $+12''.54$, and not $+22''.54$, and therefore φ must be changed into $4^{\circ} 24' 28''.41$.

Since 1853, I have computed the perturbations by *Jupiter* and *Saturn*, and it is now possible again to correct the elements. The following four normal places deserve great confidence, since they are derived from meridian-observations, only one refractor-observation being among them. The comparison of the observations is made with the ephemerides published in the "*Berliner Jahrbuch*".

Berlin M. T.	① α	C.—O.	① δ	C.—O.	Place of Observation.
	^h ^m ^s	^s	[°] ['] ["]	["]	
1853 April 14.49650	14 48 43.10	— 2.20	— 3 35 21.9	+25.1	Petersburg Meridian.
14.54331	48 40.61	1.93	35 8.9	19.0	Berlin "
18.53021	45 25.40	2.15	25 53.1	20.9	" "
19.52690	44 34.36	1.76	23 40.1	17.6	" "
20.47677	43 45.90	2.15	21 41.4	18.6	Petersburg "
21.47345	42 54.00	2.03	19 44.1	22.7	" "
23.46679	41 8.94	1.99	16 0.1	26.1	" "
27.45341	37 35.25	2.49	9 22.8	19.4	" "
28.45005	36 40.93	2.23	8 1.5	20.9	" "
April 29.49349	35 44.00	2.00	6 39.9	19.2	Berlin "
May 9.62120	26 42.92	2.43	— 3 0 31.0	21.5	Washington : mean of 2 obs.
Mean .....	.....	— 2.124	.....	+21.03	
Apr. 23.5 : computation	.....	14 ^h 41 ^m 5.19	.....	— 3° 15 30.40	
Normal place (true {	.....	14 ^h 41 7.314	.....	— 3° 15 51.43	
equinox) ..... {	.....	220° 16 49.71	.....		
Reduction to the mean	.....	.....	.....	.....	
equinox 1854 Jan. 0,	.....	+48.87	.....	—14.91	
	.....	220° 17 38.58	.....	— 3° 16 6.37	

Berlin M. T.	(1) α	C.—O.	(1) δ	C.—O.	Place of Observation.
	^h ^m ^s	^s	[°] ['] ["]	["]	
1854 July 19.55064	21 19 11.83	+ 1.00	—27 51 27.6	+11.8	Berlin Meridian.
20.54740	18 25.97	1.13	28 1 11.5	8.4	" "
24.53229	15 11.58	0.91	27 15.1	3.0	Kremsmünster Meridian.
24.53433	15 11.18	0.91	27 52.5	9.6	Berlin Meridian.
25.52899	14 21.80	0.80	34 20.2	7.6	Kremsm. "
25.53103	14 24.58	0.92	34 17.9	4.5	Berlin "
26.52773	13 34.21	0.73	40 43.4	4.1	" "
29.51573	10 59.02	0.86	59 29.0	4.1	Kremsm. "
29.51777	10 59.01	0.76	28 59 30.6	5.0	Berlin "
30.51239	10 6.34	0.83	29 5 33.8	5.0	Kremsm. "
Aug. 1.50774	8 49.86	0.67	17 31.8	(13.9)	Berlin "
3.50103	6 32.15	0.75	28 47.7	9.4	" "
6.19094	3 49.30	1.09	41 47.6	6.3	" "
8.48422	2 1.48	0.55	54 52.0	10.1	" "
9.47881	1 7.20	0.93	59 35.1	6.2	Kremsm. "
9.48085	21 1 7.42	0.60	29 59 36.7	7.5	Berlin "
13.46535	20 57 33.63	0.90	30 17 12.5	6.4	Kremsm. "
14.16200	20 56 41.33	+ 0.70	—30 21 14.0	+ 7.3	" "
Mean .....	.....	+ 0.836	.....	+ 6.84	
Aug. 2.5 : computation	21 ^h 7 27.07		—29° 23	0.30	
Normal place (true { equinox)..... {	21 ^h 7 26.234		—29° 23	7.14	
Reduction to the mean equinox 1854 Jan. 0,	316° 51 33.51				
	 —20.01		 —	1.65	
	316° 51 13.50		—29° 23	8.79	
Berlin M. T.	(1) α	C.—O.	(1) δ	C.—O.	Place of Observation.
	^h ^m ^s	^s	[°] ['] ["]	["]	
1855 Oct. 19.53535	2 44 7.40	+ 4.22			Altona Meridian.
22.52546	41 35.93	4.38	+ 3 34 56.3	— 8.6	" "
22.53333	41 35.37	4.53	34 54.9	8.4	Bonn "
23.52215	40 44.18	4.37	32 19.2	5.7	Altona "
28.49387	36 18.61	4.23	20 36.5	10.6	Kremsm "
31.49541	33 33.78	4.61	14 24.6	7.5	Altona "
Nov. 2.48868	31 43.71	4.69	10 47.7	7.1	" "
2.49655	31 43.48	4.49	10 47.9	8.1	Bonn "
3.47371	30 49.87	4.14	9 13.6	11.1	Kremsm. "
8.46847	26 15.49	4.70	2 36.3	9.8	Altona "
9.46511	25 21.88	4.50	3 1 37.2	8.0	" "
12.44344	22 43.72	4.55	2 59 31.2	7.0	Kremsm. "
13.44010	21 52.16	4.31	59 4.7	6.4	" "
13.45170	20 21 51.37	+ 4.50	+ 2 59 6.7	— 8.6	Altona "
Mean .....	.....	+ 4.444	.....	— 7.63	
Nov. 1.5 : computation	2 ^h 32 42.99		+ 3° 12 25.00		
Normal place (true { equinox)..... {	2 ^h 32 38.546		+ 3° 12 32.63		
Reduction to the mean equinox 1854 Jan. 0,	38° 9 38.19				
	 — 1 15.93		 —	30.41	
	38° 8 22.26		+ 3° 12	2.22	

Berlin M. T.	α	C.—O.	δ	C.—O.	Place of Observation.
1857 Jan. 31.56093	^h 10 ^m 25 ^s 39.53	— 1.79	[°] +25 ['] 53 ["] 19.6	+10.2	Berlin meridian.
Feb. 8.53492	19 28.32	1.64	26 58 6.9	8.9	" "
9.53161	18 37.76	1.61	27 5 43.5	9.6	" "
16.50825	12 28.07	1.55	27 51 16.8	10.3	" "
17.50489	11 33.98	1.68	28 1 4.0	11.0	" "
20.49479	8 50.66	1.51	18 41.1	11.2	" "
21.49113	7 56.52	1.63	24 12.8	10.0	" "
22.48806	7 2.39	1.58	29 26.8	10.1	" "
26.47462	3 29.64	1.65	48 2.5	10.1	" "
27.47128	10 2 37.74	— 1.69	+28 52 8.3	+ 6.8	" "
Mean .....	.....	— 1.633	.....	+ 9.82	
Feb. 13.5 : computation	10 ^h 15	8.63	+27° 34	47.80	
Normal place (true } equinox) }	10 ^h 15 10.263 153° 47 33.95		+27° 34 37.98		
Reduction to the mean equinox 1854 Jan. 0,	 — 2 41.25		 +51.77		
	153° 41 52.70		+27° 35 29.75		

ELEMENTS TO BE CORRECTED.

1854 Jan. 0 M. T. Berlin.

M	113° 19 12.67	} m. eq. ep.
π	148 55 23.11	
Ω	80 50 50.79	
i	10 37 8.54	
φ	1 24 28.41	
μ	769 .63875	
$\log \mu$	2.8862869	
$\log a$	0.4424791	

The perturbations by M and h for the dates of the normals in units of the 7th decimal, and counted from 1854 Jan. 0, are :

$x-x^0$	$y-y^0$	$z-z^0$
+ 2306	— 8784	— 3838
+ 1966	— 9638	— 3219
+10096	— 54139	—24234
+18304	—139662	—71215

The computation of the normals from the above elements, in combination with the differential coefficients, gave the following equations of condition :

$$\begin{aligned}
 0 &= +14.24 +1.51739 dM +2.71639 d\varphi +1.42547 d\pi +0.06682 d\Omega +0.48512 di - 3.69484 \cdot 100 d\mu \\
 0 &= + 7.65 +1.28275 +0.85088 +1.48075 -0.05719 +0.20881 + 2.79900 \\
 0 &= +28.14 +1.30680 -2.52347 +1.37132 +0.06610 +0.46509 + 8.77602 \\
 0 &= +57.89 +1.80566 -0.10766 +1.54341 -0.06392 +0.43087 +20.69320
 \end{aligned}$$

$$\begin{aligned}
 0 &= + 2.02 -0.75341 dM -1.27342 d\varphi -0.69790 d\pi +0.19915 d\Omega +0.99559 di + 2.02780 \cdot 100 d\mu \\
 0 &= + 0.01 +0.23970 +0.25475 +0.27396 +0.16982 -1.13364 + 0.37482 \\
 0 &= + 4.15 +0.63387 -1.19901 +0.67331 -0.19101 -0.94311 + 4.10715 \\
 0 &= -15.05 -0.56245 +0.22294 -0.48148 -0.11255 +1.38914 - 6.20909
 \end{aligned}$$

From which are derived :

$$\begin{aligned}
 &+10.25927 dM - 1.85626 d\varphi + 9.93010 d\pi -0.17001 d\Omega -0.01138 di + 51.47508 \cdot 100 d\mu + 182.2999 = 0 \\
 &+ 1.85626 +17.65609 + 1.54923 -0.03090 +0.15967 - 40.82441 - 42.9531 = 0 \\
 &+ 9.93040 + 1.54923 + 9.73449 -0.16838 -0.00592 + 47.29294 + 168.1967 = 0 \\
 &- 0.17001 - 0.03090 - 0.16638 +0.13507 +0.05618 - 0.77826 - 0.0274 = 0 \\
 &- 0.01138 + 0.15967 - 0.00592 +0.05618 +5.77694 + 0.88368 + 23.7144 = 0 \\
 &+51.47508 -40.82441 +47.29294 -0.77826 +0.88368 +586.38689 +1528.2757 = 0
 \end{aligned}$$

$$ns = +1859.5058, as = +73.3396, bs = -19.6310, cs = +68.3348, ds = -0.9543, es = +6.8592, fs = +644.4363, nn = 4652.21.$$

It will be remembered, that in all these calculations of perturbations of the coördinates, the equator is adopted as fundamental plane.

The solution of these six final equations gives :

$$\begin{aligned} dM &= -50.27 \\ d\varphi &= +0.95 \\ d\pi &= +10.31 \\ d\Omega &= -19.68 \\ di &= -3.78 \\ d\mu &= -0.01399; \end{aligned}$$

so that the corrected elements are :

CERES.

1854 Jan. 0 Berlin M. T.

$$\begin{aligned} M &= 113^\circ 18' 22.40 \\ \pi &= 148.56 \quad 3.72 \\ \Omega &= 80.50 \quad 31.11 \\ i &= 10.37 \quad 4.76 \\ \varphi &= 4.24 \quad 29.36 \\ \mu &= 769.62476 \\ \log \mu &= 2.8862790 \\ \log a &= 0.4424850 \end{aligned} \quad \left. \begin{array}{l} \\ \\ \\ \\ \\ \end{array} \right\} \text{m. eq. ep.}$$

These elements represent the normal places as follows :

$$\begin{aligned} \Delta \alpha \cos \delta &= \Delta \delta \\ &+0.09 \quad -0.11 \\ &+0.15 \quad -0.27 \\ &-0.07 \quad +0.05 \\ &-0.12 \quad -0.39 \end{aligned}$$

The substitution of the corrections in the equations of condition gives :

$$\begin{aligned} \Delta \alpha \cos \delta &= \Delta \delta \\ &+0.01 \quad +0.03 \\ &+0.09 \quad -0.32 \\ &-0.00 \quad -0.06 \\ &-0.09 \quad -0.33; \end{aligned}$$

by which the correctness of the whole is proved.

II. EPHEMERIS FOR THE OPPOSITION OF 1858.

Mean Washington Midnight.

1858	① α	① δ	$\log \Delta$	$\log r$	1858	① α	① δ	$\log \Delta$	$\log r$
	^h ^m ^s	[°] ['] ^{''}				^h ^m ^s	[°] ['] ^{''}		
April 30	17 37 41.27	-20 33 41.1	0.296375	0.445868	June 6	17 10 49.97	-22 4 12.3	0.256572	
May 1	37 21.31	35 59.3	294465		7	9 51.34	6 31.7	256622	0.450408
2	36 59.73	38 15.9	292586	446112	8	8 52.64	8 56.2	256739	
3	36 35.54	40 33.8	290738		9	7 53.93	11 16.7	256924	450641
4	36 11.75	42 53.0	288924	446356	10	6 55.28	13 36.5	257175	
5	35 45.37	45 13.4	287145		11	5 56.76	15 55.3	257491	450873
6	35 17.42	47 34.9	285403	446600	12	4 58.42	18 13.2	257879	
7	34 47.94	49 57.5	283699		13	4 0.35	20 30.0	258331	451104
8	34 16.93	52 21.1	282035	446841	14	3 2.61	22 45.6	258849	
9	33 44.41	54 45.7	280411		15	2 5.27	25 0.2	259432	451335
10	33 10.41	57 11.2	278830	447083	16	1 8.37	27 13.8	260080	
11	32 34.97	20 59 37.6	277293		17	17 0 12.00	29 26.5	260793	451565
12	31 58.09	21 2 4.8	275801	447324	18	16 59 16.21	31 38.3	261569	
13	31 19.79	4 32.6	274356		19	58 21.05	33 49.1	262407	451794
14	30 40.11	7 1.1	272960	447565	20	57 26.57	35 59.1	263308	
15	29 59.12	9 30.1	271613		21	56 32.83	38 8.2	264269	452023
16	29 16.83	11 59.8	270316	447805	22	55 39.89	40 16.5	265290	
17	28 33.26	14 30.0	269071		23	54 47.80	42 24.0	266370	452251
18	27 48.47	17 0.7	267880	448045	24	53 56.60	44 30.8	267508	
19	27 2.51	19 31.7	266743		25	53 6.34	46 36.9	268703	452478
20	26 15.43	22 3.0	265661	448284	26	52 47.07	48 42.5	269953	
21	25 27.24	24 34.4	264635		27	51 28.83	50 47.5	271258	452701
22	24 38.02	27 5.8	263666	448522	28	50 41.65	52 52.0	272617	
23	23 47.81	29 37.2	262755		29	49 55.57	54 56.0	274028	452930
24	22 56.67	32 8.5	261904	448760	30	49 10.64	56 59.6	275490	
25	22 4.63	34 39.5	261114		July 1	48 26.90	22 59 2.8	277002	453155
26	21 11.75	37 10.3	260385	448997	2	47 41.38	23 1 5.8	278562	
27	20 18.08	39 40.7	259718		3	47 3.13	3 8.6	280171	453379
28	19 23.67	42 10.7	259113	449234	4	46 23.18	5 11.5	281826	
29	18 28.56	44 40.2	258570		5	45 44.57	7 14.4	283527	453602
30	17 32.81	47 9.2	258091	449470	6	45 7.31	9 17.2	285271	
31	16 36.50	49 37.6	257677		7	44 31.45	11 20.0	287058	453825
June 1	15 39.67	52 5.4	257327	449706	8	43 56.99	13 22.7	288885	
2	14 42.39	54 32.5	257043		9	43 23.97	15 25.4	290752	454046
3	13 44.72	56 58.8	256826	449941	10	42 52.41	17 28.2	292658	
4	12 46.72	21 59 24.5	256673		11	16 42 22.34	-23 19 31.0	0.294600	0.454267
5	11 48.45	22 1 48.9	256589	450175					

g 1858 June 8, 15^h 152.7 M. T. Washington. Intensity of light = 0.926. r is the undisturbed radius vector in the ellipse 1854 Jan. 0.

OBSERVATIONS OF ARIADNE, EGERIA AND PHOCEA,

MADE WITH THE FILAR MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Lieutenant MAURY.—Corrected for refraction.]

ARIADNE.

Date.	M. T. Washington.	No. Comp.	Comparison-Star.	④ — *		④'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	[°] ['] ["]
1857 May 26	9 29 41.1	16	Weisse XIII. 33	+0 29.60	— 11 19.32	13 4 19.34	— 11 21 27.25
29	9 45 32.1	3	"	+0 37.37	— 1 32.30	13 4 27.10	11 11 39.43
"	9 58 33.7	3	"	+0 36.95	— 1 30.17	13 4 26.68	11 11 37.29
June 2	9 6 2.1	9	"	+1 17.49	+ 8 19.34	13 5 7.20	11 1 48.04
3	10 23 36.5	14	"	+1 32.65	+10 17.87	13 5 22.36	10 59 49.57
5	9 40 53.7	12	Weisse XIII. 87	— 0 24.01	— 8 41.37	13 5 59.73	10 56 36.06
6	9 10 32.8	3	"	— 0 3.21	— 7 24.54	13 6 20.52	10 55 18.80
11	9 10 9.2	14	Struve C. G. 1510	+1 7.78	— 15 55.28	13 8 37.11	10 51 55.22
14	9 24 43.2	12	Weisse XIII. 153	+0 28.60	— 8 45.32	13 10 22.36	10 52 42.65
15	9 14 55.8	14	B. A. C. 4455	— 1 14.16	+ 2 7.93	13 11 0.61	10 53 16.11
19	9 8 45.0	12	"	+1 38.02	— 2 15.32	13 13 52.78	10 57 39.17
20	9 15 0.5	21	Weisse XIII. 223	+0 34.50	+ 0 47.72	13 14 40.38	10 59 11.13
22	9 24 39.9	12	"	+2 15.07	— 2 56.83	13 16 20.92	11 2 55.51
23	9 19 27.9	6	"	+3 7.13	— 5 3.60	13 17 12.96	11 5 2.55
July 6	9 12 1.9	7	B. A. C. 4560	— 2 28.61	+15 36.67	13 30 56.18	11 48 0.09
7	8 49 21.7	12	"	— 1 16.27	+11 21.57	13 32 8.51	11 52 15.15
8	8 56 27.4	12	"	— 0 1.38	+ 6 54.49	13 33 23.39	11 56 42.24
12	8 59 12.2	14	Weisse XIII. 654	+0 20.55	— 0 52.81	13 38 35.46	12 15 56.39
13	9 10 28.9	5	"	+0 10.17	— 9 38.00	13 39 56.88	12 21 2.15
14	9 1 9.9	9	"	— 1 25.70	— 2 5.00	13 41 18.50	12 26 16.23
15	8 45 16.7	14	"	— 0 2.99	— 7 18.55	13 42 41.21	12 31 29.59
17	8 59 3.3	5	"	+2 3.33	+15 51.54	13 45 31.61	12 42 25.38
25	9 10 49.4	4	"	— 1 19.90	+ 1 27.81	13 57 39.83	— 13 29 56.36

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
		^h ^m ^s		[°] ['] ["]	
Weisse XIII. 33	9	13 3 57.29	Weisse's Catalogue.	— 11 10 49.70	Y ¹ .*
" 87	9	13 6 31.33	"	10 47 54.66	Y ¹ .
Struve C. G. 1510	7	13 7 36.95	Struve, Catalogus Gen.	10 36 42.29	Struve, Cat. Generalis.
Weisse XIII. 153	7	13 10 1.40	Weisse's Catalogue.	10 44 39.51	Weisse's Catalogue.
B. A. C. 4455	7	13 12 22.40	B. A. Catalogue.	10 56 5.97	B. A. Catalogue.
Weisse XIII. 223	8	13 14 13.52	Wash. Equat. 12 Comp.	11 0 40.83	Wash. Equat. 12 Comp.
B. A. C. 4560	7	13 33 32.60	B. A. Catalogue.	12 4 16.89	B. A. Catalogue.
Weisse XIII.* 654	8	13 38 22.75		12 15 43.36	
" 674	9	13 39 51.55		12 12 3.81	
" 731	8	13 42 52.06		12 24 50.50	
" 743	7	13 43 36.18		12 58 56.09	
" 1035	7	13 59 7.76		— 13 32 2.91	

* The declination of this star in Weisse should probably have been $-11^{\circ} 0' 36''.5$, instead of $-11^{\circ} 2' 36''.5$.

EGERIA.

Date.	M. T. Washington.	No. Comp.	Comparison-Star.	⑬ — *		⑬'s apparent	
				<i>A</i> α	<i>A</i> δ	α	δ
1857 June 20	11 11 25.8	7	LaCaille 7325	+2 48.82	+4 21.43	17 25 51.32	-40 59 34.91
	22 10 32 28.4	8	"	+0 24.93	+0 24.03	17 23 30.43	-11 3 32.59
	23 10 20 38.9	6	"	-0 46.71	-1 19.01	17 22 18.64	-41 5 15.71

Adopted Mean Place 1860.0 of 7325 LaCaille.

$$\begin{array}{cc} \alpha & \delta \\ 17^{\text{h}} 23^{\text{m}} 8^{\text{s}}.52 & -41^{\circ} 3' 53''.91 \end{array}$$

This determination is from observation with the Mural Circle by Professors YARNALL and MAJOR.

PHOCEI.

Date.	M. T. Washington.	No. Comp.	Comparison-Star.	⑳ — *		㉓'s apparent	
				<i>A</i> α	<i>A</i> δ	α	δ
1857 July 6	10 17 21.2	10	Bessel Zone 299, 167	-0 51.14	-16 13.23	18 56 45.55	+20 17 21.11
	7 9 50 16.2	12	"	-1 36.23	-10 11.24	18 56 0.47	20 53 23.33
	13 9 52 35.0	12	Rümker 6881	+0 50.89	+5 44.28	18 51 27.81	21 17 25.35
	14 10 6 42.5	12	"	+0 6.62	+7 35.86	18 50 43.54	21 19 17.16
	15 9 36 30.3	11	"	-0 35.60	+8 52.78	18 50 1.33	21 20 34.32

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
Bessel Zone 299, 167	7.8	18 57 11.68	+21 3 53.24	Y ¹ .
Rümker 6881	8.9	18 50 41.84	+21 11 56.67	Rümker's Catalogue.

THIRD COMET OF 1857.

THE following series of observations, compiled from the *Astron. Nachrichten*, will be of interest and value to the readers of this journal :

Date.	Place.	M.T. of place.	$\angle \alpha$	$\angle \delta$
June 22	Göttingen	13 19 3.0	3 26 3.63	+10 6 35.6
	Hamburg	13 12 22	3 32 39.48	41 0 15.1
	Berlin	12 56 53	3 32 27.56	40 59 38.5
	Göttingen	13 5 41.8	3 39 44.67	41 56 9.1
	Berlin	13 18 36	3 39 43.47	41 56 6.8
	Altona	13 15 54	3 39 47.43	—
	"	13 25 57	—	41 56 39.9
	Hamburg	13 21 33	3 39 48.79	41 56 28.3
	Leipsic	12 15 23.9	3 39 26.18	41 53 44.1
	Altona	13 12 59.6	3 47 36.18	—
June 25	"	13 11 54.1	—	42 52 50.3
	Bonn	13 27 5.3	3 47 15.45	42 53 24.6
	Berlin	13 6 31	3 47 29.55	42 51 48.7
	Leipsic	12 35 29.9	3 47 20.47	42 50 49.4
	Bonn	13 13 9.2	3 56 58.26	43 19 32.1
	Bilk	13 31 57.0	3 56 23.99	43 50 14.5
	Göttingen	13 15 53.3	3 56 12.09	+13 49 7.9
	"	"	"	"
	"	"	"	"
	"	"	"	"

Date.	Place.	M.T. of place.	$\angle \alpha$	$\angle \delta$
June 27	Vienna	13 0 32.0	4 5 21.37	+44 43 38.3
	Königsb.	12 26 2.6	4 15 15.24	45 36 46.8
	Florence	14 45 1.5	4 16 35.16	45 42 57.2
July 2	Padua	14 6 29.4	4 27 39.38	46 34 46.7
	Altona	12 4 18	5 7 26.24	—
	"	12 4 33	—	48 45 32.0
	Königsb.	12 51 16.4	5 7 28.60	48 45 37.4
	"	11 35 23.4	5 22 37.47	49 15 41.8
	"	11 32 56.1	5 39 43.09	49 37 30.2
	"	11 36 9.8	6 36 34.54	49 20 57.8
	"	12 13 53.5	7 16 27.70	47 42 50.4
	"	12 7 19.9	8 10 7.75	43 4 5.8
	Padua	9 28 2.1	8 8 12.51	43 13 53.3
July 14	"	9 27 45.8	8 38 2.42	39 0 31.0
	"	9 17 47.1	8 50 17.59	+36 41 38.0

The elements published in N° 104 of this Journal cannot be far from correct : as indicated both by the near accordance of the ephemeris with observation, and by the close similarity of all the elements in orbits more recently computed.

G.

ELEMENTS AND EPHEMERIS OF THE FOURTH COMET OF 1857.

COMPUTED BY JAMES C. WATSON.

Ann-Arbor, Michigan.

By means of my first approximate elements (*Astron. Journal*, N° 105), the observations at Albany, July 27 and 29, were reduced, and a normal place was taken out; and from this normal, in combination with the following observations :

1857	Ann-Arbor M. T.	$\ell\alpha$	$\ell\delta$
August 10	15 ^h 33 ^m 51 ^s .8	5 ^h 56 ^m 54 ^s .98	+39° 41' 15".9
23	15 41 58.0	7 0 34.46	+22 21 38.8,

a new system of parabolic elements was computed.

The elements are the following :

$$\begin{aligned} T &= 1857 \text{ August } 23.540176 \text{ Wash. M. T.} \\ \pi &= 21^\circ 44' 46.3 \\ \Omega &= 201 \ 18 \ 43.8 \\ i &= 32 \ 54 \ 34.4 \\ \log q &= 9.873767 \end{aligned} \left. \vphantom{\begin{aligned} T \\ \pi \\ \Omega \\ i \\ \log q \end{aligned}} \right\} \text{Mean Equinox 1857.0}$$

Motion Direct.

The comparison of the middle place gives :

Comp.—Obs.

$$\Delta\alpha \cos \delta = +36''.8, \quad \Delta\delta = -17''.9$$

These elements give the following

EPHEMERIS FOR WASHINGTON MEAN MIDNIGHT.

1857	$\ell\alpha$	$\ell\delta$	$\log \Delta$
Sept. 4	7 ^h 44 ^m 0 ^s	+9° 51' 0	9.9706
5	7 47 19	8 57.1	
6	7 50 34	8 4.5	
7	7 53 46	7 13.3	
8	7 56 56	6 23.4	9.9944
9	8 0 3	5 34.7	
10	8 3 6	4 47.3	
11	8 6 7	4 1.0	
12	8 9 5	3 15.9	0.0170
13	8 12 1	2 31.9	
14	8 14 54	1 49.0	
15	8 17 44	1 7.2	
16	8 20 31	+0 26.3	0.0381
17	8 23 16	-0 13.6	
18	8 25 58	0 52.6	

1857	$\ell\alpha$	$\ell\delta$	$\log \Delta$
Sept. 19	8 ^h 28 ^m 38 ^s	-1° 30' 7	
20	8 31 15	2 7.9	0.0582
21	8 33 49	2 44.2	
22	8 36 21	3 19.8	
23	8 38 50	3 54.6	
24	8 41 17	4 28.6	0.0766
25	8 43 41	5 1.9	
26	8 46 3	5 34.5	
27	8 48 22	6 6.4	
28	8 50 39	6 37.4	0.0937
29	8 52 54	7 8.4	
30	8 55 6	7 38.5	
Oct. 1	8 57 16	8 8.0	
2	8 59 23	-8 36.9	0.1093

Ann-Arbor, 1857 Sept. 4.

In a letter to the Editor, Sept. 7, Mr. WATSON gives the results of his computation for elliptic elements. He had found it impossible to obtain, by Olbers's method, a parabola which would represent the middle place nearer than within 3' or 4'; and was compelled to resort to tentative variations in the value of M , in order to reduce the residuals to the minimum given in his communication. Mr. WATSON's elliptic elements are as follows, and seem decidedly to support the hypothesis of periodicity, corresponding to an orbit of about 175 years.

ELLIPTIC ELEMENTS.

$$\begin{aligned} T &= 1857 \text{ August } 23.827193 \\ \pi &= 21^\circ 47' 6.5 \\ \Omega &= 200 \ 44 \ 3.3 \\ i &= 32 \ 45 \ 2.9 \\ \varphi &= 77 \ 31 \ 16.3 \\ \log a &= 1.499778 \\ \log \mu &= 1.300340 \end{aligned}$$

Washington M. T. Mean Equinox 1857.0.

Motion Direct.

The comparison of the middle place with this orbit gives $\Delta\lambda = +0''.07$, $\Delta\beta = +3''.1$.

G.

NEW ASTEROID.

LETTER FROM NORMAN POGSON, ESQ., TO THE EDITOR.

2 South Parade, Oxford, 1857, Aug. 18.

I HAVE the pleasure to inform you of the discovery of a forty-sixth asteroid, detected on Sunday evening the 14th instant, with the five-feet Smythian telescope of the Hartwell House Observatory, which Dr. LEE has most kindly lent me for private use in leisure hours.

The present observations of the new planet are :

		Oxford M. T.	App. R. A.	App. Decl.	Comp. a Star.
1857	Aug. 16	9 ^h 49 ^m 10 ^s	20 ^h 20 ^m 27 ^s 16	-16° 20' 53.7	5, a
		10 47 24	20 25.61	21 2.0	4, a
		12 29 51	20 22.69	21 18.4	6, a
	17	12 17 56	20 19 39.54	-16 25 22.0	4, b

Magnitude 11.5. The mean places of the comparison-stars for 1857.0 were :

		α	δ
a	= A.Z. 249, 62	7	20 ^h 22 ^m 42 ^s 60
b	= A.Z. 249, 55	9.10	20 16 27.33
			-16° 28' 2.4

The approximate place of this asteroid, Aug. 25.5, was 20^h 14^m 48^s, -16° 54'.4.

NORMAN POGSON.

COMET 1857 V.

ANOTHER Comet was detected by Dr. KLINKERFUES, in Göttingen, on the 20th August. At 9^h 45^m Göttingen mean time it was near the star Oeltzen's Argelander 5900, the approximate position of this star being

$$\alpha = 5^{\text{h}} 21^{\text{m}} 30^{\text{s}}, \quad \delta = +77^{\circ} 1'.$$

The daily motion in right-ascension was $10^{\circ} \frac{1}{2}$; in declination, $+2^{\circ} \frac{1}{3}$.

This comet is at present visible to the naked eye, having a tail about 3° in length. It may be found not far from the intersection of a line drawn from γ *Ursæ majoris* to *Arcturus* with the perpendicular from α *Coronæ*.

There is reason to believe that this comet has been subsequently seen at the Cambridge Observatory; but no observation has yet been received, nor the customary notification of discovery been made to astronomers. G.

Cambridge, 1857 September 11.

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NEW ASTEROID (46th), BY NORMAN POGSON, ESQ.

FIFTH COMET OF 1857.

THE ASTRONOMICAL JOURNAL.

No. 107.

VOL. V.

ALBANY, 1857, OCTOBER 24.

NO. 11.

NOTE ON THE PROPER MOTION OF THE STAR (6TH MAGNITUDE) B. A. C. 3567.

[From a letter of Dr. PETERS to the Editor.]

— WHEN I wrote to you some time ago about the considerable proper motion of the Star B. A. C. 3567 (the position of which is given in that catalogue from GROOMBRIDGE'S observations alone). I was not aware of the same remark having been already made by Dr. OUDEMANS in the *Astr. Nachr.* N° 889, nor of Mr. WINNECKE'S discussion *ibid.* N° 1036. As my results differ a little from the latter gentleman's, I collect here the places as derived from the

several sources, and reduced with Bessel's precession to the beginning of 1857. To the Radcliffe declinations, the corrections from Vol. XV, pag. xxvi, have been applied; and to Groombridge's position, the correction found by FEDORENKO (in the introduction to his catalogue of Lalande's circumpolar stars), the uncertainty in regard to the exact date of observation remaining, of course, for the latter position.

Authority.	Date.	No. Obs.	α	δ	Error in	
					α	δ
Lalande, Fedorenko 1688.	1790, 13	1, 1	^h ^m ^s 10 19 12.10	[°] ['] ["] 49 33 49.8	^s +0.15	["] —0.7
Groombridge 1646.....	(1810)	6, 6	10 19 12.68	49 33 29.7	—0.15	+1.3
Radcliffe Observations....	1841, 24	—, 2	—	49 33 2.5	—	+0.2
" " " " " " " "	1842, 28	5, —	10 19 13.08	—	—0.09	—
Argelander. Oeltzen 10844	1843, 22	1, 1	10 19 12.73	49 33 0.8	+0.27	+0.3
Radcliffe Observations....	1845, 28	—, 2	—	49 33 0.6	—	—1.5
" " " " " " " "	1847, 26	1, —	10 19 13.15	—	—0.09	—
" " " " " " " "	1848, 30	1, —	10 19 13.01	—	+0.06	—
Leyden (A. N., N° 889) ..	1849, 26	—, 2	—	49 32 55.5	—	—0.1
Radcliffe Observations....	1852, 24	—, 2	—	49 32 53.0	—	—0.3
Berlin (A. N., N° 1036) ..	1855, 16	—, 1	—	49 32 48.9	—	+1.2
Dudley Observatory	1857, 25	—, 6	—	49 32 48.4	—	—0.2

The last two columns show the residual errors, after the application of annual corrections for proper motion of

$$+0''.0142 = +0''.213 \text{ in right-ascension,}$$

$$\text{and } -0''.907 \text{ in declination :}$$

the former resulting from a simple comparison of the mean of LALANDE'S and GROOMBRIDGE'S right-ascensions with the mean of the modern observations; the latter presenting the least sum of the squares, with a mean error of $\pm 0''.396$ in the value for 1857, and of $\pm 0''.014$ in the coefficient for proper motion.

The declination determined at the Dudley Observatory rests upon six comparisons by the zenith-telescope with 34 *Leonis minoris*, the position of which ($\delta = +35^\circ 43' 24''.5$ for 1857) is seemingly well established.

The final position of the star thus becomes (for 1857.0)

$$\alpha = 10^h 19^m 13^s.20 + 0''.0142 \cdot t,$$

$$\delta = +49^\circ 32' 48''.4 - 0''.907 \cdot t;$$

which shows the declination of the Brit. Assoc. Catalogue to be already in error more than 40 seconds.

C. H. F. PETERS.

ELEMENTS AND EPIHEMERIS OF IRIS FOR 1858.

BY ERNEST SCHUBERT.

[Communicated by Professor WINLOCK, Superintendent American Ephemeris.]

I. PERTURBATIONS OF IRIS BY JUPITER AND SATURN, FROM 1848 JAN. 0 TO 1858 JULY 19.0.

	di	$d\Omega$	$d\varphi$	$d\pi$	$d\mu$	$fd\mu$	dM
$\mathcal{M}$	— 16.39	— 547.21	— 55.15	— 364.17	— 0.22649	— 340.24	— 66.48
$\frac{1}{2}$	+ 0.81	— 13.93	— 3.51	+ 19.71	— 0.00403	+ 28.51	— 37.02
$\mathcal{M} + \frac{1}{2}$	— 15.55	— 9' 21.14	— 58.66	— 5' 44.46	— 0.23052	— 5' 11.73	— 1 43.50

II. EPIHEMERIS FOR THE OPPOSITION OF 1858.

Berlin Mean Midnight.

1858	$\odot$ α	$\odot$ δ	$\log \Delta$	$\log r$	1858	$\odot$ α	$\odot$ δ	$\log \Delta$	$\log r$
June 17	^h 20 ^m 12 ^s 53.62	[°] —15 ['] 45 ["] 32.4	0.200294	0.395228	July 20	^h 19 ^m 44 ^s 13.14	[°] —15 ['] 33 ["] 20.3	0.142959	
18	12 22.48	43 58.5	197660		21	43 8.69	33 58.7	142439	0.380133
19	11 49.70	42 29.7	195064	394376	22	42 4.33	34 39.3	142001	
20	11 15.28	41 5.9	192508		23	41 0.16	35 21.9	141643	379206
21	10 39.25	39 47.0	189994	393520	24	39 56.23	36 6.3	141365	
22	10 1.62	38 32.6	187524		25	38 52.63	36 52.6	141168	378275
23	9 22.40	37 23.9	185100	392659	26	37 49.44	37 40.6	141051	
24	8 41.62	36 19.6	182723		27	36 46.73	38 30.3	141015	377339
25	7 59.31	35 20.0	180396	391794	28	35 44.59	39 21.6	141058	
26	7 15.49	34 25.1	178119		29	34 43.09	40 14.3	141181	376400
27	6 30.19	33 34.8	175895	390924	30	33 42.30	41 8.3	141382	
28	5 43.46	32 49.2	173725		31	32 42.29	42 3.6	141661	375457
29	4 55.32	32 8.2	171612	390049	Aug. 1	31 43.14	42 59.8	142017	
30	4 5.82	31 31.8	169556		2	30 41.92	43 57.1	142449	374510
July 1	3 11.99	30 59.9	167560	389169	3	29 47.70	44 55.3	142956	
2	2 22.88	30 32.5	165625		4	28 51.57	45 54.4	143538	373559
3	1 29.54	30 9.5	163751	388285	5	27 56.58	46 54.3	144192	
4	20 0 35.01	29 50.9	161947		6	27 2.81	47 54.8	144917	372604
5	19 59 39.35	29 36.6	160206	387397	7	26 10.31	48 55.8	145714	
6	58 42.62	29 26.5	158533		8	25 19.16	49 57.1	146580	371645
7	57 44.87	29 20.5	156929	386504	9	24 29.40	50 58.6	147515	
8	56 46.15	29 18.6	155397		10	23 41.11	52 0.2	148516	370683
9	55 46.54	29 20.5	153938	385607	11	22 54.33	53 1.9	149582	
10	54 46.11	29 26.2	152552		12	22 9.12	54 3.6	150711	369717
11	53 44.93	29 35.5	151242	384706	13	21 25.53	55 5.3	151900	
12	52 43.08	29 48.3	150008		14	20 43.60	56 6.9	153149	368748
13	51 40.62	30 4.5	148851	383800	15	20 3.37	57 8.2	154455	
14	50 37.64	30 23.9	147771		16	19 24.89	58 9.0	155817	367775
15	49 34.22	30 46.3	146770	382890	17	18 48.18	15 59 9.3	157232	
16	48 30.43	31 11.7	145848		18	18 13.27	16 0 9.0	158700	366798
17	47 26.34	31 39.9	145005	381975	19	17 40.19	1 8.2	160218	
8 18	46 22.05	32 10.8	144242		20	19 17 8.98	—16 2 6.6	0.161785	0.365818
19	19 45 17.62	—15 32 44.3	0.143560	381056					

8 1858 July 18 1^h 54^m 8^s.6 M. T. Washington; intensity of light = 0.969.

III. OSCULATING ELEMENTS.

Epoch = 1858 July 19.0 Berlin M. T.

$$M = 281^{\circ} 5' 23.53$$

$$\pi = 41 29 15.26$$

$$\Omega = 259 46 16.06$$

$$i = 5 28 1.43$$

$$\phi = 13 20 45.94$$

$$\mu = 962''.63348$$

$$\log \mu = 2.9834610$$

$$\log a = 0.3776970$$

Referred to mean equinox of epoch.

EPHEMERIS OF EUNOMIA FOR THE OPPOSITION OF 1858.

BY ERNEST SCHUBERT.

[Communicated by Professor WINLOCK, Superintendent American Ephemeris.]

Washington Mean Midnight.

1858	(15) α	(15) δ	$\log \Delta$	$\log r$	1858	(15) α	(15) δ	$\log \Delta$	$\log r$
Jan. 20	^h 10 ^m 40 ^s 8.35	[°] 1 ['] 50 ^{''} 16.3	0.306323	0.451715	Feb. 26	^h 16 ^m 8 ^s 55.00	[°] 1 ['] 23 ^{''} 41.9	0.282705	
21	39 33.89	52 24.2	304729		27	7 59.18	20 31.7	283259	0.461229
22	38 58.11	54 22.4	303175	452244	28	7 3.81	17 16.9	283878	
23	38 21.00	56 10.1	301661		March 1	6 8.98	13 57.6	281562	461700
24	37 42.59	57 48.0	300189	452768	2	5 14.74	10 34.1	285309	
25	37 2.91	1 59 16.0	298760		3	4 21.12	7 7.1	286120	462168
26	36 22.01	2 0 33.8	297376	453289	4	3 28.18	3 36.8	286992	
27	35 39.90	1 41.5	296038		5	2 35.97	1 0 3.4	287927	462632
28	34 56.61	2 39.2	294746	453807	6	1 11.51	0 56 27.4	288922	
29	34 12.19	3 26.8	293501		7	0 53.93	52 49.0	289977	463094
30	33 26.65	4 4.4	292312	454322	8	10 0 4.20	49 8.5	291091	
31	32 40.06	4 31.9	291171		9	9 59 15.38	45 26.0	292263	463552
Feb. 1	31 52.45	4 49.4	290082	454835	10	58 27.54	41 41.9	293493	
2	31 3.83	4 56.9	289047		11	57 10.71	37 56.8	294779	464008
3	30 14.26	4 54.5	288067	455345	12	56 54.92	34 10.9	296120	
4	29 23.80	4 42.3	287143		13	56 10.24	30 24.6	297514	464460
5	28 32.48	4 20.3	286275	455852	14	55 26.68	26 38.2	298960	
6	27 40.36	3 48.6	285466		15	54 54.30	22 52.0	300458	464910
7	26 47.49	3 7.3	284717	456356	16	54 3.10	19 6.3	302005	
8	25 53.92	2 16.5	284027		17	53 23.14	15 21.2	303601	465357
9	24 59.70	1 16.3	283400	456857	18	52 44.43	11 37.0	305244	
10	24 4.85	2 0 6.8	282835		19	52 7.00	7 54.2	306933	465801
11	23 9.46	1 58 42.1	282333	457354	20	51 30.88	1 12.9	308666	
12	22 13.59	57 20.5	281895		21	50 56.07	0 0 33.5	310411	466241
13	21 17.30	55 44.6	281521	457848	22	50 22.62	+ 0 3 3.6	312256	
14	20 20.64	54 0.2	281214		23	49 50.54	6 38.4	314112	466678
15	19 23.68	52 7.6	280971	458340	24	49 19.85	10 10.5	316006	
16	18 26.50	50 7.0	280795		25	48 50.55	13 39.9	317937	467111
17	17 29.13	47 58.8	280685	458829	26	48 22.66	17 6.2	319903	
18	16 31.64	45 43.1	280643		27	47 56.21	20 29.1	321902	467542
19	15 34.12	43 20.2	280668	459315	28	47 31.18	23 48.7	323935	
20	14 36.60	40 50.3	280760		29	47 7.59	27 4.7	325999	467970
21	13 39.15	38 13.8	280918	459799	30	46 45.43	30 16.8	328092	
22	12 41.83	35 31.0	281143		31	46 24.71	33 24.9	330214	468395
23	11 44.70	32 42.1	281435	460279	April 1	46 5.11	36 28.8	332364	
24	10 47.80	29 47.4	281792		2	9 45 47.53	+ 0 39 28.3	0.334539	0.468816
25	10 9 51.22	— 1 26 47.3	282216	0.460755					

8 1858 February 23, 14^h 0^m 23.9 M. T. Washington; intensity of light = 0.619. r is the undisturbed radius-vector in the ellipse 1854 Jan. 0.

EPHEMERIS OF THALIA FOR THE OPPOSITION OF 1858.

BY ERNEST SCHUBERT.

[Communicated by Prof. WINLOCK, Superintendent American Ephemeris.]

Washington Mean Midnight.

1858	23 <i>a</i>	23 <i>δ</i>	log Δ	log <i>r</i>	1858	23 <i>a</i>	23 <i>δ</i>	log Δ	log <i>r</i>
March 1	^h 13 ^m 56 ^s 34.84	+ 2 49 50.8	0.162188	0.354597	April 7	^h 13 ^m 31 ^s 31.46	+ 4 53 12.3	0.132150	
2	56 23.23	52 59.3	160316		8	30 32.27	55 7.6	132753	371983
3	56 9.67	56 13.0	158483	355499	9	29 32.99	56 53.5	133437	
4	55 54.16	2 59 31.5	156691		10	28 33.72	58 29.7	134202	372906
5	55 36.72	3 2 54.5	154944	356402	11	27 34.52	4 59 55.9	135050	
6	55 17.31	6 21.6	153236		12	26 35.48	5 1 11.9	135977	373829
7	54 56.04	9 52.6	151577	357308	13	25 36.68	2 17.3	136984	
8	54 32.84	13 27.0	149967		14	24 38.20	3 12.0	138070	374752
9	54 7.76	17 4.6	148407	358215	15	23 40.12	3 55.6	139234	
10	53 40.78	20 45.0	146899		16	22 42.50	4 27.8	140476	375674
11	53 11.96	24 27.9	145445	359125	17	21 45.42	4 49.0	141793	
12	52 41.34	28 12.7	144047		18	20 48.97	4 58.5	143186	376596
13	52 8.97	31 59.0	142707	360036	19	19 53.22	4 56.4	144653	
14	51 34.88	35 46.3	141427		20	18 58.23	4 42.6	146193	377518
15	50 59.11	39 34.2	140208	360949	21	18 4.06	4 17.2	147804	
16	50 21.69	43 22.3	139053		22	17 10.75	3 39.8	149483	378440
17	49 42.65	47 10.2	137962	361863	23	16 18.35	2 50.8	151229	
18	49 2.00	50 57.4	136937		24	15 26.93	1 49.9	153040	379361
19	48 19.82	54 43.5	135981	362778	25	14 36.56	5 0 37.4	154915	
20	47 26.18	3 58 28.0	135093		26	13 47.26	4 59 13.1	156853	380282
21	46 51.14	4 2 10.5	134276	263695	27	12 59.12	57 37.2	158853	
22	46 4.77	5 50.5	133531		28	12 12.14	55 49.7	160912	381201
23	45 17.11	9 27.5	132860	364613	29	11 26.39	53 50.6	163029	
24	44 28.22	13 1.2	132263		30	10 41.90	51 40.0	165201	382120
25	43 38.17	16 31.0	131741	365532	May 1	9 58.71	49 18.0	167427	
26	42 47.01	19 56.6	131294		2	9 16.84	46 44.7	169705	383037
27	41 54.80	23 17.6	130925	366452	3	8 36.34	44 0.2	172035	
28	41 1.61	26 33.6	130633		4	7 57.23	41 4.6	174414	383954
29	40 7.50	29 44.2	130421	367372	5	7 19.55	37 57.8	176841	
30	39 12.51	32 49.0	130289		6	6 43.32	34 40.2	179314	384869
31	38 16.76	35 47.7	130237	368293	7	6 8.57	31 12.2	181831	
April 1	37 20.38	38 39.7	130266		8	5 35.33	27 33.6	184391	385784
2	36 23.38	41 24.8	130376	369215	9	5 3.61	23 44.4	186991	
3	35 25.76	44 2.5	130567		10	4 33.44	19 44.6	189630	386698
4	34 27.65	46 32.6	130840	370137	11	4 4.82	15 34.3	192306	
5	33 29.22	48 54.5	131194		12	13 3 37.77	+ 4 11 13.6	0.195017	0.387611
6	13 32 30.48	+ 4 51 7.8	0.131631	0.371060					

♂ 1858 April 8, 11^h 52 2.6 Washington M. T.; intensity of light = 2.241. *r* is the undisturbed radius-vector in the ellipse 1854.0.

PLANET-CIRCULAR.

LETTER FROM LIEUTENANT MAURY TO THE EDITOR.

U. S. N. Observatory, Washington, 1857 October 5.

I HAVE the pleasure to send you the place of a new asteroid, the 47th. It was discovered at 10 o'clock last night, by Mr. JAMES FERGUSON, with the large refractor of this Observatory.

OBSERVED PLACE OF ④7 : 11 MAG.

M. T. Washington. *a* *δ*
 1857 Oct. 4 10^h 21^m 24^s.4 0^h 57^m 20^s.24 +3° 58' 37".31

The daily motion in right-ascension is -52^s, and in declination -3' 54".

M. F. MAURY.

OBSERVATIONS OF THE COMETS 1857 IV AND 1857 V.

MADE WITH THE FILAR MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Lieutenant MAURY.—Corrected for refraction.]

FOURTH COMET OF 1857.

Date.	M. T. Washington.	No. Comp.	Comparison-Star.	☾ — *		☾'s apparent	
				<i>Aa</i>	<i>Aδ</i>	<i>a</i>	<i>δ</i>
1857 Aug. 21	^h 14 ^m 57 ^s 55.4	7		^m —0 11.21	['] +12 24.23		
23	14 41 25.1	5		—0 51.25	— 9 31.78		
29	15 7 57.2	10	Bessel Z. 276, 245	+0 9.62	+ 0 2.10	^h 7 23 ^m 38.82	+15° 36' 45.78

Adopted Mean Place for 1860.0 of Comparison-Star.

*	Mag.	<i>a</i>	<i>δ</i>	Authority.
B. Z. 276, 245	8	7 ^h 23 ^m 38. ^s 00	+15° 36' 14. ⁶ 63	Bessel's Zones.

FIFTH COMET OF 1857.

Date.	M. T. Washington.	No. Comp.	Comparison-Star.	☾ — *		☾'s apparent	
				<i>Aa</i>	<i>Aδ</i>	<i>a</i>	<i>δ</i>
1857 Sept. 7	^h 8 ^m 55 ^s 28.2	12	Bessel's Z. 270, 81	^m —1 34.08	['] —20 37.41	^h 13 37 ^m 53.44	+40° 36' 53.26
8	7 50 18.1	14	" 463, 135	—1 33.09	—10 6.62	39 46.22	38 26 24.16
9	7 55 21.2	6	" 466, 47	—1 46.96	— 7 48.64	41 27.61	36 15 23.40
10	7 46 39.9	14	" 414, 20	—0 9.17	—15 22.18	42 51.67	34 11 52.11
"	8 24 12.0	5	" 414, 16	+2 2.80	+ 7 50.27	42 53.84	34 8 46.93
11	7 55 42.4	14	" 413, 17	+1 50.01	+18 43.52	44 2.44	32 12 46.16
14	7 44 8.8	4	" 462, 67	—3 9.40	+11 12.76	46 27.79	26 51 22.14
"	7 44 8.8	4	Struve C. G. 1570	—6 5.04	+20 39.29	46 28.28	26 51 20.03
15	7 27 52.3	8	Bessel's Z. 462, 65	—1 4.34	+ 4 16.26	46 55.78	25 14 53.30
"	7 27 52.3	8	" 462, 66	—2 25.56	+ 1 0.40	46 56.39	25 14 46.84
17*	7 44 37.1	6	B. A. C. 4618	+4 31.88	+12 39.11	47 30.11	22 11 19.36
23	7 25 51.1	10	Rümker 4508	—0 29.37	— 6 11.44	46 36.41	14 26 5.75
"	7 25 45.7	9	" 4517	—2 20.84	—19 12.74	46 37.01	14 26 10.86
24	7 8 7.2	10	" 4501	—0 9.16	— 8 0.78	46 9.47	13 18 49.30
"	"	10	Weisse XIII 794	—0 36.96	— 4 20.87	46 9.37	13 18 50.18
25	7 14 53.3	16	Rümker 4483	+1 40.98	— 5 0.09	45 37.18	12 12 14.29
26	7 17 56.3	10	Weisse XIII 797	—1 53.88	+11 37.86	45 1.43	11 7 56.69
27	7 7 1.0	8	" 785	—2 0.20	+16 16.58	41 22.47	10 6 13.12
28	7 9 19.9	6	" 732	+1 0.26	— 1 30.68	43 40.17	9 5 35.24
30	6 52 20.6	6	Rümker 4471	—0 16.33	+ 6 20.30	13 42 5.10	+ 7 9 39.09

On the evenings of the 8th and 17th of September a faint tail was perceived, estimated to be 25 minutes of arc in length. It was too faint to bear any illumination, but its angle of position was approximately measured on the 17th, and found 297° 30'.

* Angle of position of the tail, 288°; length, 40'.

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	<i>a</i>	<i>δ</i>	Authority.
		^h ^m ^s	^h ^m ^s	
Bessel's Zones 270, 81	7	13 42 34.17	+10 56 39.21	Bessel's Zones.
.. 463, 135	7	41 26.06	38 35 39.54	"
.. 466, 47	8	46 21.36	36 22 21.66	"
.. 411, 20	8	43 7.74	34 26 24.01	"
.. 414, 16	8	40 57.99	34 0 35.89	"
.. 413, 17*	6	42 19.45	31 53 11.67	"
.. 462, 67	7	49 44.31	26 36 21.13	" and Rümker's Cat.
Struve Cat. Gen. 1570	7	52 10.44	26 29 52.80	Struve Catalogus Generalis.
Bessel's Zones 462, 65	9	48 7.34	25 9 48.85	Bessel's Zones.
" 462, 66	8.9	49 29.17	25 12 58.47	"
B. A. C. 4618	6	43 5.58	21 57 52.29	B. A. Catalogue.
Rümker 4508	8	47 13.37	14 31 32.20	Rümker's Catalogue.
" 4517	8	49 5.43	14 44 37.79	"
" 4501†	9	46 26.27	13 26 4.24	"
Weisse XIII 794	8	46 53.96	13 22 25.24	Weisse's Catalogue.
Rümker 4492	6	45 0.97	13 27 40.47	Rümker's Catalogue.
Weisse XIII 797	8	47 3.03	10 55 33.62	Weisse's Catalogue.
" 785	9	46 30.42	9 49 11.38	"
" 732	7	42 47.71	9 6 20.70	"
Rümker 4382	9	44 3.89	12 16 28.57	Rümker's Catalogue.
" 4471	7	13 42 29.30	+ 7 2 33.43	"

FOUR ASTEROIDS.

A. LETTER FROM MR. FERGUSON TO THE EDITOR.

Washington, 1857 October 16.

I SEND some places of the asteroid discovered on the night of the 4th instant (See Planet-Circular, p. 84). I should have thought that it might be *Leucothea*, but for the great deviation from the computed place for that planet, and the magnitude which I have estimated at (10.5). It was quite distinctly visible in bright moonlight. Farther evidence of its not being

Leucothea might, if necessary, be found in its motion in declination.

In N° 106, p. 77, the declination of Weisse XIII 87 should have been $-10^{\circ} 48' 36''.87$. It arose from putting the apparent place for the mean one. The printer has also put an unnecessary * opposite Weisse XIII 654.

J. FERGUSON.

OBSERVATIONS OF THE FIFTIETH ASTEROID.

Date.	M. T. Washington.	No. Comp.	Comparison-Star.	⑤0 — *		⑤0's apparent	
				<i>Aa</i>	<i>Aδ</i>	<i>a</i>	<i>δ</i>
				^m ^s	[°] ['] ["]	^h ^m ^s	[°] ['] ["]
1857 Oct. 4	10 21 24.1	10	B. A. C. 311	-0 59.72	-10 33.28	0 57 29.24	+3 58 37.31
5	10 31 20.8	12	"	-1 39.26	-17 22.20	0 56 49.99	+3 51 48.43
6	8 1 21.5	12	* 2	+1 18.97	-4 52.51	0 56 14.27	+3 15 43.95
7	9 4 36.2	12	* 2	+0 37.79	-11 54.42	0 55 33.09	+3 38 42.01
8	7 30 17.0	14	* 3	-0 24.01	-6 57.74	0 54 56.18	+3 32 14.25
9	7 51 51.1	10	* 3	-1 3.98	-13 41.12	0 54 16.26	+3 25 30.84

* This star is in the Catalogue of the British Association, but the place depends on an observation by BESSEL.

† The declination of this star has been diminished 1' from the declination of the Catalogue. This has been done as the result of a comparison with WEISSE XIII 794, which is 25567 of LALANDE; the two catalogues agreeing in the declination of the latter star, and there being an observed difference between this and 4501.

Adopted Mean Places 1860 of Comparison-Stars.

*	Mag.	α	δ	Authority.
B. A. C. 311	7	^h 0 58 ^m 34.93 ^s	[°] +4 9 43.60 ['] ["]	STRUVE Cat. Generalis.
* 2	9.5	0 55 0.98	+3 51 9.73	Wash. Equat. from * 3, 14 comparisons.
* 3	9	0 55 25.86	+3 39 45.30	Wash. Mural, Professor YARNALL.

B. FROM A LETTER OF DR. LUTHER TO THE EDITOR.

Bilk near Düsseldorf, 1857 September 22.

I SEND you some observations of my *sixth* planet, of the 11th magnitude.

1857 Bilk.	R. A.	Decl.	No. Comp.
Sept. 15 9 ^h 56 ^m ^s	0° 51' "	−0° 42' "	1
12 29 16.4	0 49 40.0	0 42 35.0	13
14 6 50.6	0 48 45.3	−0 42 45.1	10

daily motion −12".6, −3".2.

Berlin M. T.	R. A.	Decl.
Sept. 17 9 56 10	0 25 57.3	−0 48 38.7

Hamburg M. T.	R. A.	Decl.
Sept. 18 10 7 19	0 12 53.1	−0 52 0.1

I hope that the planet will be observed through several months by the great American instruments, as also that Professor BOND will succeed in finding *Leucothea*.

Daphne has been found by Mr. GOLDSCHMIDT as a star of the 10.11 magnitude.

1857 Paris M. T.	α	δ
Sept. 9 14 ^h 8 ^m	23 ^h 17 ^m 27 ^s	+2° 23 18

Berlin M. T.	α	δ
Sept. 16 13 ^h 0 ^m 44 ^s	348° 5' 45.3	+1° 13' 11.0
17 11 22 42	347 55 47.2	+1 3 42.2

R. LUTHER.

C. TWO MORE.

Mr. GOLDSCHMIDT, in Paris, reports twins, as follows :

FORTY-EIGHTH ASTEROID.

Paris M. T.	App. α	App. δ
Sept. 19 10 ^h	22 ^h 27 ^m 11 ^s	−5° 52'
20 12 7 ^s	22 26 23	−5 57.5

11th magnitude.

FORTY-NINTH ASTEROID.

Paris M. T.	α	δ
Sept. 22 8 ^h 24 ^m	22 ^h 27 ^m 55 ^s	−5° 9'

10th magnitude.

The new asteroid of Dr. LUTHER thus becomes the *forty-seventh*, those of Mr. GOLDSCHMIDT the *forty-eighth* and *forty-ninth*, and that of Mr. FERGUSON the *fiftieth* of the group.

G.

FIFTH COMET OF 1857.

THE following information relative to this comet is compiled from the *Astronomische Nachrichten* :

Date.	Place.	Mean Time.	α	δ
1857 Aug. 21	Berlin	^h 13 17 ^m 12.8 ^s	[°] 94 45 42.7 ['] ["]	[°] +79 37 52.0 ['] ["]
22	"	14 11 18.6	113 38 50.6	80 44 23.8
23	"	12 11 38.3	132 45 57.9	80 44 40.1
25	Altona	13 39 25.0	166 55 6.5	77 28 31.5
29	"	11 25 24.7	191 46 38.4	66 11 44.4
30	Christiania	9 18 20.5	194 24 26.7	63 22 40.0
31	"	11 10 33.1	196 50 57.9	60 3 44.8
Sept. 1	"	10 22 31.2	198 34 29.5	57 8 55.0
2	"	11 23 42.8	200 5 32.3	54 5 7.3
3	"	10 17 4.5	201 13 44.3	51 22 12.2
6	Altona	8 26 19.9	203 42 19.2	43 39 3.8
7	Christiania	9 19 9.0	204 20 58.7	+41 9 2.6

From observations of Aug. 21, 29 and Sept. 6, Mr. PAPE has computed elements and an ephemeris :

$$\begin{aligned} & \text{1857 V.} \\ T &= \text{Sept. 30.84129 Berl. M. T.} \\ \pi &= 250 \ 18 \ 12.0 \\ \Omega &= 14 \ 54 \ 7.5 \\ i &= 56 \ 7 \ 10.7 \\ \log q &= 9.751330 \\ & \text{Retrograde.} \end{aligned} \quad \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} \text{Mean Eq. 1857.0}$$

For the not improbable case that the comet may be observed in the east after the perihelion, Mr. PAPE has computed an ephemeris for the last of October and beginning of November, which will much facilitate its detection.

EPHEMERIS FOR BERLIN MEAN NOON.

Date.	$\odot \alpha$	$\odot \delta$	$\log \Delta$
1857 Oct. 29	13 ^h 15 ^m 59 ^s	—14° 3.8	0.2441
30	15 11	14 41.6	
31	14 23	15 19.3	
Nov. 1	13 35	15 56.8	
2	12 48	16 34.0	0.2459
3	12 1	17 11.0	
4	11 14	17 47.8	
5	10 28	18 24.3	
6	9 42	19 0.5	0.2455
7	8 56	19 36.4	
8	13 8 11	—20 2.0	

KEPPLER'S COMPLETE WORKS.

A COLLECTION of the works of KEPPLER, edited by Professor FRISCH of Stuttgart, with the editor's annotations and preface in Latin for the convenience of foreign readers, is now completely ready for publication. The last volume is to contain the Life of KEPPLER and a copious index. The other seven will give all the works ever published by KEPPLER, together with some *inedita*. The letters of KEPPLER will give this edition special interest : of these, some are taken from the well-known collection of HANSCH ; others are to be printed for the first time from the original MSS. furnished by the libraries of Stuttgart, Munich, Vienna, and especially from the famous collection of the Pulkowa Observatory, formerly at St.-Petersburg. The great difficulty of obtaining any of KEPPLER'S scattered works at the present day will make this collection a highly acceptable one to astronomers, while the new letters presented to the public will interest scholars of all professions.

Professor FRISCH only awaits a number of subscribers sufficient to insure that the expenses of printing will be defrayed ; and he solicits aid in his useful undertaking, from all parts of the scientific world. It is evident that without the active co-operation of all able to give their support, the publication will not be possible. The names of the subscribers will be prefixed to the first volume. The price will be at the rate of three silver-groschen the sheet (imperial *Sch.*) ; and it is estimated that each volume will contain about forty sheets, making the total about four Prussian thalers (83.00) a volume, payable on delivery in Frankfort. The figures are

to be printed with the text, and a portrait of KEPPLER will be given.

Professor FRISCH gives the following as the table of contents for the several volumes :

- I. 1. The *Prodromus Dissertationum Cosmographicarum, seu Mysterium Cosmographicum*.
2. A fragment, from the St.-Petersburg manuscripts, containing the defence of TYCHO BRAHE against RAYMARTS URSINUS.
3. Calendars and astrological writings.
- II. The Optics, Dioptries, articles upon *Jupiter's* satellites; The New Star in *Serpentarius*, and *Mercurius in Sole*.
- III. *De Motu Stellæ Martis*, and several smaller pieces : *De Nive*; On Lunar Eclipses, etc.; Hipparchus (St. Petersburg MS.).
- IV. Chronological Works; *Stereometria Doliorum* (German and Latin); Preface to the Logarithmus.
- V. *Epitome Astronomiæ Copernicanæ; De Cometis*.
- VI. *Harmonice Mundi* : Translation of the *Harmonia* of PROBLEMY, with a Commentary (St.-Petersburg MS.).
- VII. *Hyperaspistes Tychonis; Epistola ad Terrentium; Somnium*. Introduction to the Ephemerides and the *Tabulæ Rudolphinæ*.
- VIII. Life of KEPPLER; Supplements; Index.

Names of subscribers in the United States will be received and forwarded by MM. B. WESTERMANN & Co., New-York.
Cambridge, 1857 October 1. G.

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ALBANY : C. VAN BENTHUYSEN, PRINTER.

THE ASTRONOMICAL JOURNAL.

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VOL. V.

ALBANY, 1857, DECEMBER 11.

NO. 12.

COMET-CIRCULAR.

LETTER FROM R. VAN ARSDALE, ESQ., TO THE EDITOR.

Newark, November 11, 1857.

I NOTICED last evening (10th inst.) a small faint Comet, of nebulous appearance. Its approximate position at 7^h 37^m P. M. was as follows :

R.A. 15^h 35^m ; D. +55° 20'.

The right-ascension was increasing at the rate of about one minute per hour; the declination supposed to be slightly diminishing.

ROBERT VAN ARSDALE.

SIXTH COMET OF 1857.

UNDER date of November 14, Mr. VAN ARSDALE communicates the following additional observations :

“ The positions are approximate.

Newark M. T.		α	δ
1857 Nov. 11	6 ^h 22 ^m	15 ^h 57 ^m 20 ^s	+54° 52'
	12 6 33	16 20 —	+53 50

It can be seen with a comet-seeker of four inches aperture.”

Lieutenant MACRY writes, Nov. 13 : “ It was observed here last night with the large equatorial, by Mr. FERGUSON, at 6^h 53^m 36^s, in North Declination 53° 44' 31^h.44 and 16^h 22^m 15^s.47 in A.R. It moves rapidly, having since its discovery changed its place in Dec. —1° 35' 28^s.66 and +47^m 15^s.47 in A.R.”

NEW ASTEROIDS.

DR. LUTHER has selected the name *Nysa* for the 44th; Mr. GOLDSCHMIDT requests astronomers to call the 45th *Eugenia* and the 49th *Pales*; Mr. FERGUSON proposes the name *Virginia* for the 50th. The latter was independently discovered by Dr. LUTHER in Bonn Oct. 19.

From the *Astron. Nachrichten*, I glean the following additional information :

OBSERVATIONS.

FORTY-EIGHTH ASTEROID.					FORTY-NINTH ASTEROID.				
1857	Place.	M. T.	(48) α	(48) δ	1857	Place.	M. T.	(49) α	(49) δ
Sep. 27	Bonn	12 ^h 52 ^m 11 ^s	22 ^h 22 ^m 54 ^s .94	—6° 34' 57.5	Sep. 25	Berlin	12 ^h 43 ^m 40 ^s .0	22 ^h 26 ^m 9 ^s .07	—5° 19' 20.0
27	Bilk	10 11 39.8	22 22 57.95	6 34 26.4	26	Bilk	11 14 29.3	22 25 39.18	5 22 26.2
28	Berlin	13 13 33.2	22 22 27.05	6 40 2.0	29	Berlin	11 27 58.2	22 24 9.99	5 31 33.2
29	..	11 12 51.5	22 22 2.89	6 44 29.6	29	Bonn	13 32 3	22 24 7.19	5 31 45.7
Oct. 20	Vienna	9 34 15.1	22 17 17.84	8 2 54.4	30	Berlin	10 33 56.0	22 23 45.23	5 34 13.5
21	..	8 32 45.0	22 17 17.78	—8 5 9.9	Oct. 7	Vienna	10 25 18.4	22 21 16.93	—5 51 9.4

ELEMENTS.

46
1857 Aug. 16.5 Berlin M. T.
 $M = 334^{\circ} 46' 12.5$
 $\pi = 344' 56'' 16.9$
 $\Omega = 181' 30'' 45.0$
 $i = 2' 17'' 46.8$
 $\varphi = 7' 2'' 34.0$
 $\log a = 0.390385$
 $\log \mu = 2.964430$

48
1857 Oct. 6.0 Berlin M. T.
 $M = 305^{\circ} 40' 56''$
 $\pi = 61' 13'' 3$
 $\Omega = 186' 28'' 26$
 $i = 6' 8'' 55$
 $\varphi = 11' 20'' 22$
 $\log a = 0.518115$
 $\mu = 592'' 700$

49
1857 Oct. 6.0 Berlin M. T.
 $M = 23^{\circ} 48' 59.6$
 $\pi = 320' 50'' 16.2$
 $\Omega = 295' 28'' 37.0$
 $i = 3' 23'' 17.7$
 $\varphi = 5' 2'' 41.7$
 $\log a = 0.441314$
 $\mu = 772'' 745$

The elements of 46 are by Mr. PAPE, and the longitudes are referred to the mean equinox of 1857.0; those of 48 and 49, which are referred to the mean equinox of epoch, are by Mr. POWALKY of Hamburg. G.

ELEMENTS AND EPHEMERIS OF VIRGINIA.

BY JAMES FERGUSON.

ELEMENTS.

1857 Oct. 4.0 Washington M. T.
 $M = 1^{\circ} 1' 30.38$
 $\Omega = 173' 1'' 14.12$
 $\pi = 11' 5'' 45.79$
 $i = 2' 41'' 2.90$
 $\varphi = 16' 31'' 7.79$
 $\log a = 0.4141896$
 $\log \mu = 2.9287222$

These elements are computed from the Washington observations of Oct. 4, 12, 20 and 29.

OBSERVATIONS OF VIRGINIA.

Date.	M. T. Washington.	No. Comp.	Comparison-Star.	50 — *		50's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1857 Oct. 4	^h 10 ^m 21 ^s 24.4			^m ^s	['] ^{''}	^h 0 ^m 57 ^s 29.24	[°] + 3 ['] 38 ^{''} 37.50
10	8 6 39.1	13	* 3	—1 43.28	—20 23.61	53 36.93	3 18 48.57
"	8 49 47.6	4	Rümker 451	+1 15.39	+ 5 55.79	53 35.16	3 18 38.91
12	9 57 31.2	15	"	—0 3.93	— 7 36.32	52 15.86	3 5 16.75
13	7 40 36.0	9	"	—0 38.22	—13 15.92	51 41.57	2 59 27.12
17	8 9 24.3	10	B. A. C. 237	+5 14.83	— 1 41.04	49 15.13	2 35 14.92
"	"	10	Weisse O. 802	+3 4.69	+ 3 17.65	49 15.10	2 35 15.50
20	7 41 41.7	10	B. A. C. 237	+3 35.28	—18 14.49	47 35.59	2 18 41.54
"	"	10	Weisse O. 802	+1 25.15	—18 17.09	47 35.58	2 18 40.66
21	7 39 59.5	10	"	+0 53.83	—18 25.46	47 4.25	2 13 32.30
29	9 27 50.7	6	Rümker 340	—0 3.90	—19 11.75	0 43 43.19	+ 1 39 15.04

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
* 3	10	^h 0 ^m 55 ^s 25.86	[°] +3 39 45.29	Mural : Professor Yarnall.
Rümker 451	9	0 52 25.49	3 13 17.01	Rümker's Catalogue, and Yarnall.
B. A. C. 237	7	0 44 5.89	2 37 29.72	Rümker, Santini and Yarnall.
Weisse O. 802	9	0 46 16.01	2 32 31.36	Weisse's Catalogue.
Rümker 340	8	0 13 52.67	+1 59 1.46	Rümker and Yarnall.

EPHEMERIS OF VIRGINIA.

Washington Mean Time.

1857	α	δ	$\log r$	$\log \Delta$	1857	α	δ	$\log r$	$\log \Delta$
	^h ^m ^s	^o ['] ["]				^h ^m ^s	^o ['] ["]		
Nov. 13.0	0 42 28.1	+1 17 55	0.27440	0.00968	Dec. 8.0	0 55 31.0	+2 38 8		
14	42 37	18 33			9	56 21	43 55		
15	42 48	19 6			10	57 18	49 51		
16	43 2	20 3			11	58 14.5	2 55 57.0	0.28306	0.10893
17	43 17.3	1 21 16	0.27541	0.02233	12	0 59 11	3 2 10.0		
18	43 35	22 43			13	1 0 9	8 33		
19	43 54	24 27			14	1 9	15 5		
20	44 15	26 25			15	2 10.6	3 21 46	0.28458	0.12363
21	44 37.3	1 28 35	0.27650	0.03600	16	3 13	28 37		
22	45 2	31 1			17	4 17	35 34		
23	45 27	33 39			18	5 22	42 37		
24	45 55	36 32			19	6 28.5	49 51	0.28616	0.13924
25	46 25.8	1 39 38	0.27767	0.05025	20	7 35	3 57 13		
26	46 57	42 56			21	8 41	4 4 40		
27	47 31	46 26			22	9 54	12 16		
28	48 7	30 10			23	11 5.7	19 58	0.28780	0.15269
29	48 44.2	1 54 7	0.27891	0.06478	24	12 17	27 46		
30	49 23	1 58 15			25	13 29	35 40		
Dec. 1	50 4	2 2 21			26	14 44	43 40		
2	50 46	2 7 7			27	16 0.5	4 51 48	0.28951	0.16701
3	51 30.0	2 11 51	0.28022	0.07938	28	17 17	5 0 0		
4	52 15	16 46			29	18 35	8 15		
5	53 2	21 51			30	19 53	16 34		
6	53 50	27 6			31	1 21 11.2	+5 25 2	0.29126	0.18205
7	0 54 40.0	+2 32 32.5	0.28161	0.09417					

OCCULTATIONS OF THE PLEIADES, 1857 MARCH 1.

LETTER OF PROFESSOR BACHE TO THE EDITOR.

Coast-Survey Office, Washington, October 1857.

I HAVE the honor to forward to you for publication in the *Astronomical Journal*, the observations upon the occultations of the Pleiades of March 1, 1857, communicated to this office by the observers.

A. D. BACHE, *Superintendent.*

I. ANN-ARBOR OBSERVATORY, MICHIGAN.

OBSERVER : PROFESSOR F. BRÜNNOW ;

With Refractor of the Observatory.

IMMERSIONS.

	Bessel's No.	Sidereal Time.
<i>Merope</i>	17	9 ^h 16 ^m 5.2
	25	9 25 12.8
	28	9 27 39.4
	32	9 29 31.5
	31	9 34 50.8
	35	9 36 40.8
	21	9 37 53.0
	43	10 12 33.1
	47	10 24 48.4
<i>Atlas</i>	41	10 25 7.5
	51	10 28 36.2

EMERSION.

<i>Merope</i>	17	9 51 20 ::
---------------	----	------------

Remarks from Professor BRÜNNOW's letter to Professor BACHE : "The first of March was one of the roughest days of this winter : it blew a perfect gale all day, the sky was covered with heavy clouds, and I had given up every idea of observing, when in the evening it suddenly cleared up ; but the state of the atmosphere was terrible ; it was almost impossible to make any observations, and I did not succeed in observing any stars with the meridian circle till after the commencement of the occultations.—I send you here my observations, which, however, are not very accurate. The wind blew so, that it was impossible to hear the beats of the chronometer : they were counted loud by a friend of mine ; but as this was not done very distinctly, there may have arisen from this cause errors of perhaps half a second." "The emersion of *Electra* may not be very accurate, on account of the undulation of the limb of the moon. It was impossible to see the emersions of the fainter stars."

II. GALVESTON, TEXAS.

OBSERVER : TIPTON WALKER;

With 3½ f. Pollen. aperture 2½ inches, power 118; the station bearing about N 60° E 2500 feet from the north tower of the Cathedral.

IMMERSIONS.

	Bessel's No.	Sidereal Time.
<i>Electra</i>	2	7 ^h 58 ^m 2 ^s 1
		8 16 20.6 ::
<i>Merope</i>	17	8 26 49.1
		8 56 46.1 ::
	27	8 58 14.0
<i>Aleyone</i>	34	9 0 50.1
<i>Atlas</i>	41	9 39 57.5
	40	9 41 47.0
<i>Pleione</i>	42	9 42 30.5

EMERSIONS.

<i>Electra</i>	2	8 47 10
<i>Maia</i>	11	9 27 40.5

From Mr. WALKER's remarks : "The smaller stars seemed to linger near the faintly illuminated dark limb of the moon, and to gradually fade out" (as those marked doubtful ::). "I think the recorded times of the immersions of the larger stars may be relied on to within less than a half second. I was not so successful with the emersions (two of which, on account of clouds, were only observed). . . . but I think they are within much less than a second of the truth. From sunrise of the 1st, until late in the afternoon of that day, the sky was quite clear, and the heat as oppressive as in midsummer. About dark a very fresh *norther* set in, which made it uncomfortably cool, and produced great atmospheric disturbances. The air was so dry that I could not get good definitions with my transit instrument. . . ."

III. MOBILE, ALABAMA.

OBSERVER : EDWARD GOODFELLOW;

With Zenith Telescope U. S. C. S. No. 5. Place of observation: Public Square, 74.1 feet north of centre of Transit of C. S. Station.

IMMERSIONS.

	Bessel's No.	Sidereal Time.
<i>Electra</i>	2	8 ^h 36 ^m 35 ^s 38
<i>Merope</i>	17	8 56 11.73
<i>Aleyone</i>	34	9 31 37.83
<i>Atlas</i>	41	10 6 21.46
<i>Pleione</i>	42	10 10 52.09

IV. MONTGOMERY, ALABAMA.

OBSERVER : GEORGE W. DEAN;

With 46-inch Telescope of Troughton and Simms, belonging to U. S. C. S. Transit No. 6, adjusted upon a wooden frame : aperture 2½ inches, power 85. Observed in the open air on the south side of the State House, and 40 yards south of the C. S. astronomical station : the times recorded chronographically.

IMMERSIONS.

	Bessel's No.	Sidereal Time.	Notes.
<i>Electra</i>	2	8 ^h 54 ^m 32 ^s 5	perhaps noted 0 ^s .3 too soon.
<i>Merope</i>	17	9 3 10.3	well observed : star moderately bright, but tremulous.
<i>Aleyone</i>	34	9 41 30.4	well observed.
<i>Atlas</i>	41	10 12 47.9	This observation was made with great difficulty : star very faint through dense haze; and the observed time, as recorded by clock, is estimated by the observer to be 0 ^s .2 too late.

From the remarks of Mr. DEAN : "The wind blew a fresh gale from the NW, and. . . the observer labored under much difficulty from the tremulous motion of the telescope. During the early portion of the night the atmosphere was quite clear; but at 11 p.m. it began to grow hazy, and soon became so dense that the emersion of *Aleyone* and the immersion of *Pleione* were lost, while the immersion of *Atlas* was observed with great difficulty. The moon disappeared in the haze more than a half hour before the time of setting."

V. SAN FRANCISCO, CALIFORNIA.

C. S. ASTRON. STATION RINCON.

OBSERVER : GEORGE DAVIDSON;

With Reconnoitring Telescope No. 18, mounted upon a tripod stand power 89.

IMMERSIONS.

	Star	Sidereal Time.	Notes.
	5	5 ^h 38 ^m 58 ^s .90	very faint, doubtful.
<i>Electra</i>	2	5 42 32.70	very distinct, very good.
	12	5 50 36.89	very faint, doubtful.
<i>Merope</i>	17	5 57 54.68	very distinct, very good.
	24	6 22 47.13	very faint, doubtful.
	16	6 24 43.62	faint, moderately good.
	15	6 25 44.52	faint, good.
	31	6 32 34.31	" "
	28	6 36 15.40	" "
	23	6 37 41.80	very faint, doubtful.
	27	6 38 31.30	very good.
	26	6 40 3.90	faint, good.
<i>Aleyone</i>	34	6 41 14.30	very distinct, very good.
	25	6 50 30.98	faint, moderately good.
<i>Atlas</i>	41	7 27 17.22	very distinct, very good.
	40	7 29 21.22	" "
<i>Pleione</i>	42	7 30 24.32	" "
	43	7 34 56.41	very faint, moderately good.
	46	7 45 2.39	" "
	51	8 10 40.06	distinct, good.
	50	8 11 20.35	" "
	53	8 21 58.94	" "

From Mr. DAVIDSON's remarks : "The ash-grey limb of the moon distinct and well defined; and as the smaller stars approached it, they became less distinct. Those marked "doubtful" may be in error 1^s or 2^s; those "moderately good", ½^s; those "good", and also those marked "very good", are to the nearest tenth of the second. All these are the extreme limits. Telescope would not show Nos 7, 19, 24 and 22. At commencement, atmosphere very tremulous; at 7^h 30^m sidereal time, moderately tremulous, but rather hazier; at 8^h 10^m, hazy and tremulous."

OBSERVATION OF THE ALGOL-MINIMUM OF 1856 DEC. 4, AT WASHINGTON CITY

BY CHARLES A. SCHOTT,

ASSISTANT U. S. COAST SURVEY.

SKY perfectly clear : moon near setting at the commencement of the observations.

TIME OF MINIMUM BY COMPARISON WITH

Time by Watch.	Comparison of Brightness.	
^h ^m	$\rho = \delta$	$\rho \frac{3}{4} \rho$
11 9	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
15	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
21	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
27	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
33	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
39	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
45	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
51	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
57	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
12 3	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
9	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
15	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
21	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
27	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
33	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
39	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
45	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
51	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$
57	$\delta = \rho$	$\frac{3}{4} \frac{3}{4} \frac{3}{4}$

nearly

δ	ρ
at $\frac{h}{m}$ 12 3.0	12 $\frac{h}{m}$ 9.0 at $\frac{h}{m}$ 3 4
$\frac{1}{4}$, 4.5	7.5 $\frac{1}{2}$
$\frac{1}{2}$, 6.0	3.0 $\frac{1}{4}$
	0.0 $\frac{1}{4}$
Mean 12 4.5	12 4.9

Watch slow of Wash. M. T. $\frac{h}{m}$ 12 4.7
0.3

Observed minimum 12 5.0 Washington M. T.

NOTE. On Dec. 7, about the time of the *Algol*-minimum, ρ was decidedly brighter than β , and nearly or quite as bright as δ .

EPHEMERIS OF ALGOL-MINIMA : 1857 - 1858.

BY STILLMAN MASTERMAN.

THE annexed table of minima of the variable star β *Persei* comprises those visible in America during the remainder of 1857 and 1858, and are given in Washington mean times. They have been computed with the following elements, de-

duced by ARGELANDER; the equation of light having been applied.

Epoch 1854 Oct. 8, $0^h 12^m 84^s$ M. T. Washington.
Period $2^d 20^h 48^m 52^s$.

1857 Sep. 28 $16^h 48^m$	1857 Nov. 19 $7^h 25^m$	1858 Jan. 21 $9^h 25^m$	1858 Apr. 20 $6^h 50^m$	1858 Aug. 27 $7^h 20^m$	1858 Nov. 12 $17^h 14^m$
Oct. 1 $13^h 37^m$	30 $18^h 41^m$	24 $6^h 14^m$	May 24 $16^h 37^m$	Sep. 10 $15^h 23^m$	15 $14^h 2^m$
4 $10^h 26^m$	Dec. 3 $15^h 30^m$	Feb. 7 $14^h 20^m$	Jun. 16 $15^h 7^m$	13 $12^h 12^m$	18 $10^h 51^m$
7 $7^h 14^m$	6 $12^h 19^m$	10 $11^h 10^m$	Jul. 6 $16^h 47^m$	16 $9^h 0^m$	21 $7^h 40^m$
18 $18^h 29^m$	9 $9^h 8^m$	13 $7^h 59^m$	9 $13^h 36^m$	30 $17^h 3^m$	Dec. 5 $15^h 45^m$
21 $15^h 17^m$	12 $5^h 57^m$	16 $4^h 48^m$	12 $10^h 24^m$	Oct. 3 $13^h 52^m$	8 $12^h 34^m$
24 $12^h 6^m$	23 $17^h 13^m$	Mar. 2 $12^h 54^m$	29 $15^h 15^m$	6 $10^h 40^m$	11 $9^h 23^m$
27 $8^h 55^m$	26 $14^h 2^m$	5 $9^h 44^m$	Aug. 1 $12^h 4^m$	9 $7^h 29^m$	14 $6^h 12^m$
30 $5^h 44^m$	29 $10^h 52^m$	8 $6^h 33^m$	4 $8^h 53^m$	23 $15^h 32^m$	25 $17^h 28^m$
Nov. 10 $16^h 59^m$	1858 Jan. 1 $7^h 41^m$	25 $11^h 28^m$	18 $16^h 55^m$	26 $12^h 21^m$	28 $14^h 17^m$
13 $13^h 48^m$	15 $15^h 47^m$	28 $8^h 17^m$	21 $13^h 44^m$	29 $9^h 10^m$	31 $11^h 7^m$
16 $10^h 36^m$	18 $12^h 36^m$	Apr. 17 $10^h 1^m$	24 $10^h 32^m$	Nov. 1 $5^h 58^m$	

Weld (Me.), 1857 September 18.

FROM A LETTER OF PROFESSOR BRÜNNOW TO THE EDITOR.

Ann-Arbor, 1857 November 2.

DURING my absence from the Observatory, Mr. WATSON has made a few observations of *Clio* with the Meridian Circle. The observed apparent positions are as follows :

Ann-Arbor M. T.			(12) α	(12) δ
1857 July 31	13 ^h 2 ^m 24.7		21 ^h 41 ^m 41.95	+4° 51' 42.0
Aug. 10	12 15 44.0		21 34 13.84	4 44 55.1
18	11 37 54.9		21 27 55.69	4 13 8.9
27	10 56 11.5		21 21 34.60	3 17 21.9

Owing to a mistake, which, at the same time had influence on the calculation of the 7 normal places, the ephemeris given in N° 1077 of the *Astronomische Nachrichten* for the oppositions of 1857 needs the following small corrections :

	$\Delta\alpha$	$\Delta\delta$
Aug. 1.5	+0.25	+6.7
9.5	+0.08	+6.1
17.5	-0.10	+5.3
25.5	-0.27	+4.1
Sep. 2.5	-0.42	+2.9

If I compare Mr. WATSON'S observations with the ephemeris thus corrected, I find the following small errors of my ephemeris :

July 31	-0.44	+1.2
Aug. 10	-0.48	+1.2
18	-0.45	+1.7
27	-0.46	-4.3

Omitting the last declination, I find the mean error for August 13,

$$\Delta\alpha \cos \delta = -6.9$$

$$\Delta\delta = +1.4;$$

and from this, the corrections which must be added to the

elliptical elements in N° 1077 of the *Ast. Nachrichten* are as follows :

$$\begin{aligned}\Delta\pi &= +0.29 \\ \Delta\Omega &= +0.03 \\ \Delta i &= -1.62 \\ \Delta M &= -0.48 \\ \Delta\varphi &= +0.81 \\ \Delta\mu &= +0.0006505\end{aligned}$$

The last elliptical elements would therefore be the following :

1851 Jan. 0 : Berlin M. T.

$$M = 66^{\circ} 2' 39.84$$

$$\pi = 301^{\circ} 39' 25.02$$

$$\Omega = 235^{\circ} 34' 41.74$$

$$i = 8^{\circ} 23' 17.74$$

$$\varphi = 12^{\circ} 38' 44.90$$

$$\mu = 994.8347237$$

$$\log a = 0.3681389;$$

and these elements represent the 8 normal places in a very satisfactory way, leaving only the following small errors :

	$\Delta\alpha \cos \delta$	$\Delta\delta$
1850 Sep. 21.5	-2.2	+2.3
Oct. 3.5	+2.0	+0.7
1851 Feb. 25.5	0.0	-0.3
1852 Jan. 20.5	-1.6	+1.0
1853 Apr. 18.5	0.0	+1.7
1854 Dec. 2.5	-0.3	+0.1
1856 Feb. 28.5	+2.6	+1.4
1857 Aug. 13.75	-0.4	+0.4

FR. BRÜNNOW.

MEAN PLACES FOR 1860.0 OF COMPARISON-STARs,
USED IN OBSERVATIONS OF *EGERIA*, *PHOEBE* AND *ARIADNE*.

DETERMINED FROM OBSERVATIONS WITH THE WASHINGTON MURAL CIRCLE,

BY PROFESSORS YARNALL AND MAJOR.

Lacaille 7325.		
1857	α	δ
June 19	17 ^h 23 ^m 8.52	-41° 3' 53.47
20		54.98
22		53.49
25		51.60
Aug. 3		54.27
14		-41 3 55.66

Rümker 6881.

July 25	+26 11 53.41
Aug. 12	+26 11 53.60

Bessel, Zone 299, 67.		
1857	δ	
July 7	+21° 3'	53.02
25	+21 3'	52.40

Weisse XIII, 33.

June 6	-11 10 49.75
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Weisse XIII, 87.

June 6	-10 48 36.67
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OBSERVATIONS OF THE COMET 1857 VI.

MADE WITH THE FILAR MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Lieutenant MAURY.—Corrected for refraction.]

Date.	M. T. Washington.	No. Comp.	Comparison-Star.	— * —		s's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
	h m s			m s	" "	h m s	° ' "
1857 Nov. 12	6 53 36.6	2	A. Z. 9, 24	+9 48.00	+10 41.61	16 22 5.61	+53 44 48.92
14	7 25 10.1	5	" 8, 56	+2 8.83	—15 40.43	17 6 55.11	50 45 46.09
15	7 11 46.2	2	Rümker 5943	—6 31.77	+16 47.10	17 26 22.65	48 57 7.05
17	7 17 17.0	5	Rümker 6208	+2 1.90	—17 1.06	18 0 36.36	+44 50 56.54

Adopted Mean Places for 1860.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
		h m s	° ' "	
A. Z. 9, 24	7	16 12 22.53	+53 33 47.09	} Argelander's Zones.
" 8, 56	7	17 4 51.32	51 1 16.55	
Rümker 5943	6	17 32 58.21	48 40 6.09	} Rümker's Catalogue.
Rümker 6208	8	17 58 39.71	+45 7 38.28	

The Comet is very faint and shapeless, and is observed with great difficulty. It has increased slightly in brightness since the 12

FROM A LETTER OF MR. GOLDSCHMIDT TO THE EDITOR.

Paris, 1857 October 22.

I SEND you a few observations of my new planets.

Comparison-Star of October 13 and 15.

FORTY-EIGHTH ASTEROID.

Paris M. T.	α	δ
	48	48
1857 Sep. 20 12 ^h 7 ^m	22 ^h 26 ^m 34.50	—5° 57' 3"
21 10 35	22 26 3.52	—6 3 13
22 11 5	22 25 29.27	—6 7 37
24 8 28	22 24 27.47	—6 18 24

The declination on the 24 is uncertain, on account of the great distance from the comparison-star, which amounted to 24' 18".

FORTY-NINTH ASTEROID. *PALES.*

Paris M. T.	α	δ
	49	49
1857 Sep. 21 9 ^h 37 ^m	22 ^h 28 ^m 32.22	—5° 3' 50"
22 8 24	22 27 58.52	5 8 16
24 9 52	22 26 46.12	
" 9 57		5 15 41
27 8 22	22 25 10.50	
" 8 30		5 25 17
Oct. 13 8 35	22 20 12.94	5 59 38
15 7 53	22 20 2.52	—6 2 29

	Mag.	α	δ
(Berlin Cat. & Chart 1800), 9	22 ^h 15 ^m 52 ^s	—6° 11' 36"	
Mean place 1857.0	22 18 50.58	—5 54 29	
App. place Oct. 15	22 18 53.94	—5 54 10	

I was able to see the planet on the evening of Oct. 20, a little to the south, without appreciable change of the motion in α ; but the foggy weather did not permit me to observe it. The weather has been very unfavorable for the last three weeks. At the last the planet resembled a star of (11.12) magnitude. I have not been able to see the forty-eighth again with certainty. The variable star *Mira Ceti* was, on the 22 and 26 of August of this year, equal in brilliancy to its companion, which I estimate of the (10.11) magnitude. On the 24 of September the variable was a *very little* brighter, and we can consider the period of increase as beginning with this day. On the 12 of October I found it (9.10) magnitude; on the 15 of October, (9) magnitude at 12^h 40^m. The color is a fine red like that of transparent rouge.

R Tauri (HIND'S) I recognized on the 12 of October; on the 13, it was of the 11 magnitude, and very visible.

HERMANN GOLDSCHMIDT.

ELEMENTS AND EPHEMERIS OF THE FORTY-SEVENTH ASTEROID.

BY DR. C. BRUHNS.

ELEMENTS :

From Observations of Sept. 17, Oct. 6 and Oct. 25.

Epoch 1857 Oct. 6.0 Berlin M. T.

M	43° 53' 42.8
π	306 1 22.1
Q	4 24 59.1
i	5 5 48.8
φ	8 3 32.1
μ	722.413
$\log a$	0.460814

EPHEMERIS.

Berlin Mean Midnight.

Date.	(47) α	(47) δ	$\log \Delta$	Date.	(47) α	(47) δ	$\log \Delta$
	^h ^m ^s	[°] [']			^h ^m ^s	[°] [']	
Nov. 22	23 36 12	—1 27.2		Dec. 4	23 41 49	—0 37.1	
23	36 33	23.7		5	42 25	32.2	
24	36 56	20.0	0.3363	6	43 2	27.2	0.3694
25	37 20	16.2		7	43 40	22.1	
26	37 45	—1 12.4		8	44 18	—0 17.0	
27	38 11	1 8.4		9	44 58	0 11.7	
28	38 39	1 4.2	0.3474	10	45 39	0 6.3	0.3802
29	39 8	0 59.9		11	46 21	—0 0.8	
30	39 38	—0 55.6		12	47 4	+0 4.8	
Dec. 1	40 9	51.2		13	47 48	+0 10.5	
2	40 41	46.6	0.3585	14	23 48 33	+0 16.3	0.3908
3	23 41 14	—0 41.9					

COMET 1857 VI.

THIS was detected by Professor DONATI at Florence on the evening of the 10th of November, and observed as follows :

	Florence M. T.	$\swarrow \alpha$	$\swarrow \delta$
Nov. 10	7 ^h 5 ^m 34 ^s	232° 8 59	+55° 44 12
	9 33 34	232 48 4	

Professor PETERS observed it at Altona :

	Altona M. T.	$\swarrow \alpha$	$\swarrow \delta$
Nov. 15	7 ^h 33 ^m 26 ^s 8	260° 30 22.1	+49° 22 21.6
	7 35 37.7		

Mr. VAN ARSDALE's discovery was on the same evening as Prof. DONATI's, and within a few minutes of the same local time
Cambridge, 1857 Dec. 3. G.

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NO. 13.

THE INFLUENCE OF THE EARTH'S ROTATION UPON THE RELATIVE MOTION OF BODIES NEAR ITS SURFACE.

BY W. FERREL.

IF a body upon or near the earth's surface receive a motion relatively to the earth, either by means of a single impulse or by a continually acting force, this motion, combined with the rotatory motion of the earth, gives rise to a deflecting force relatively to the earth, which causes a different relative motion from that of a body acted upon in a similar manner upon the earth at rest. It is proposed, in this paper, to examine a few of the effects produced by this deflecting force.

Let x , y and z be three rectangular coördinates having their origin at the center of the earth, x corresponding with the axis; and P , Q and R be the forces which act respectively in the directions of these ordinates. We shall then have

$$\frac{ddx}{dt^2} = P; \quad \frac{ddy}{dt^2} = Q; \quad \frac{ddz}{dt^2} = R. \quad [1]$$

$$\sin \theta \frac{ddr}{dt^2} + 2 \cos \theta \frac{dr}{dt} \cdot \frac{d\theta}{dt} - r \sin \theta \frac{d\theta^2}{dt^2} + r \cos \theta \frac{dd\theta}{dt^2} - r \sin \theta \left(n + \frac{d\pi}{dt} \right)^2 = \cos (nt + \varpi) Q + \sin (nt + \varpi) R \quad [4]$$

Multiplying equation [3] by $\cos \theta$ and equation [4] by $\sin \theta$, and adding, we get the first of equations [5]. Multiplying the former by $\sin \theta$ and the latter by $\cos \theta$, and subtracting, we get the second of equations [5]. Again, after sub-

$$\begin{aligned} \frac{ddr}{dt^2} - r \frac{d\theta^2}{dt^2} - r \sin^2 \theta \left(n + \frac{d\pi}{dt} \right)^2 &= \cos \theta P + \sin \theta \cos (nt + \varpi) Q + \sin \theta \sin (nt + \varpi) R; \\ -r \frac{dd\theta}{dt^2} - 2 \frac{dr}{dt} \cdot \frac{d\theta}{dt} + r \sin \theta \cos \theta \left(n + \frac{d\pi}{dt} \right)^2 &= \sin \theta P - \cos \theta \cos (nt + \varpi) Q - \cos \theta \sin (nt + \varpi) R; \\ -r \sin \theta \frac{dd\pi}{dt^2} - 2 \sin \theta \left(n + \frac{d\pi}{dt} \right) \frac{dr}{dt} - 2 r \cos \theta \left(n + \frac{d\pi}{dt} \right) \frac{d\theta}{dt} &= (\sin nt + \varpi) Q - \cos (nt + \varpi) R. \end{aligned} \quad [5]$$

The preceding equations may be applied to the relative motions of a body acted upon by any forces whatever. We shall first apply them to the motions of projectiles; and in the application, we shall neglect all quantities of the order of the earth's ellipticity; and, also, as the range of motion is generally small, all quantities of the order of the range of motion compared with the earth's radius. We shall also, in integrating, consider $\sin \theta$ and $\cos \theta$ constant quantities. We

Let r = the distance of the body from the earth's center
 θ = its polar distance
 ϖ = its longitude [printed π in the fractions]
 nt = the rotatory motion of the earth.

We shall then have

$$x = r \cos \theta; \quad y = r \sin \theta \cos (nt + \varpi); \quad z = r \sin \theta \sin (nt + \varpi) \quad [2]$$

Substituting the second differential of the value of x in the first of equations [1], we get

$$\cos \theta \frac{ddr}{dt^2} - 2 \sin \theta \frac{dr}{dt} \cdot \frac{d\theta}{dt} - r \cos \theta \frac{d\theta^2}{dt^2} - r \sin \theta \frac{dd\theta}{dt^2} = P \quad [3]$$

Substituting in like manner the second differentials of y and z in the last two of equations [2], and multiplying the former by $\cos (nt + \varpi)$ and the latter by $\sin (nt + \varpi)$, and adding, we get

stituting the second differentials of y and z , as stated above, in the last two of equations [1], if we multiply the former by $\sin (nt + \varpi)$ and the latter by $\cos (nt + \varpi)$, and subtract, we get the last one of the following equations.

shall then have $P = -\cos \theta g r^{-2}$,
 $Q = -\sin \theta \cos (nt + \varpi) g r^{-2}$,
and $R = -\sin \theta \sin (nt + \varpi) g r^{-2}$,
in which g = the force of gravity at the distance of unity.

Substituting these values in the righthand members of equations [5], the first becomes $-g r^{-2}$, and the other two become 0. As $\frac{d\pi}{dt}$ and $\frac{d\theta}{dt}$ are generally small in comparison with n ,

and very nearly constant, we shall, in integrating, use the initial values of those quantities. We may hence deduce from equations [5],

$$\begin{aligned} \alpha &= ut - \frac{1}{2}gr^{-1}t^2 + \frac{v^2}{2r'}t^2 + \frac{\sin\theta(n'+w)^2}{2r'}t^2 \\ \beta &= rt - \frac{ur}{r'}t^2 + \frac{g'r}{3r'}t^3 + \frac{\cos\theta(n'+w)^2}{2r'}t^2 \\ \gamma &= wt - \frac{u}{r'}(n+w)t^2 + \frac{n'+w}{3r'}gt^3 - \frac{\cos\theta(n'+w)r}{r'\sin\theta}t^2; \end{aligned} \quad [6]$$

in which

$\alpha = \int dr$ = the vertical motion in the time t
 $\beta = \int r' d\theta$ = the linear motion in latitude
 $\gamma = \int r \sin\theta d\varpi$ = the linear motion in longitude
 u = the initial vertical velocity
 v = the initial velocity in latitude
 w = the initial velocity in longitude
 r = the value of r at the earth's surface
 $n' = r' \sin\theta n$ = the linear velocity of the earth's surface
 $g = gr^{-1} - r \sin^2\theta n^2$ = gravity at the earth's surface, diminished by the effect of the earth's rotation.

If in these equations we put $n' = 0$, they will be the equations of motion upon the earth without a rotatory motion. If we make r' infinite, we have the ordinary equations of parabolic motion, in which the directions of gravity are considered parallel. If we retain $\frac{\sin\theta n'^2}{2r'}t^2 = \frac{1}{2}\sin^2\theta n$, contained in the last term of the first equation, which depends upon the earth's rotation alone, we still have the equations of motion in a parabola, but in this case the effect of gravity is diminished by that term; and retaining also $\frac{\cos\theta n^2}{2r'}t^2$, contained in the last term of the second equation, the direction of the axis of the parabola is changed by an angle ψ , in which $\tan\psi = \frac{\sin\theta \cos\theta}{gr^{-1} - \sin^2\theta n^2}$. The effect of n' in the preceding equations, in all ordinary cases of projectiles, is very small. If a projectile were thrown 2 miles, in any direction, in 10 seconds, the effect of the earth's rotation would deflect it from that direction, in the latitude of Cambridge, about 8 feet to the right. From the first of the preceding equations it may be seen that if w is plus, that is, if the initial velocity is east,

the projectile will ascend a little higher than when it is minus, or the initial velocity is west, all other circumstances being the same.

If in equations [6] we put r and $w = 0$, they become the equations of an ascending or descending body; and putting also $u = 0$, they become the equations of a falling body without any initial velocity. In the latter case they become

$$\begin{aligned} \alpha &= -\frac{1}{2}(gr'^{-2} - r' \sin^2\theta n^2)t^2 \\ \beta &= \frac{1}{2}r' \sin\theta \cos\theta n^2 t^2 \\ \gamma &= \frac{1}{3}\sin\theta n g t^3 \end{aligned} \quad [7]$$

The second of the preceding equations shows that a body falls south of the direction of the earth's attraction. As the first two equations evidently give the equation of a plumb-line, a falling body cannot deviate to the north or south of it. If, however, the falling body is resisted by the atmosphere, so that α is not in proportion with t^2 , they no longer give the equation of a straight line, and the effect evidently is to throw the body a little to the south of a plumb-line in the northern hemisphere, but north of it in the southern. Hence the observed deviation of falling bodies in the northern hemisphere to the south of a plumb-line, is caused by the resistance of the atmosphere together with the effect of the earth's rotation. The last of equations [7] shows that a falling body deviates to the east of a plumb-line, and that it falls in a curve convex towards it. The value of $n = \frac{2\pi}{(23 \times 60 + 56) \times 60} = .00007292$.

With this value of n , this equation gives about 7 inches for the eastern deviation of a body, in the latitude of Cambridge, in falling 10 seconds.

If a body be free to move upon the surface of the earth regarded as a perfect sphere, its motions may be determined by the last two of equations [5], the terms containing $\frac{dr}{dt}$ vanishing. The term $r \sin\theta \cos\theta n^2$, contained in the first one of those equations, gives rise to the elliptical figure of the earth. Since the resultant of this force and the earth's attraction is perpendicular to the elliptical surface, these forces cannot affect the motions of a body upon this surface. Hence we have for the motions of a body upon the elliptical surface of the earth, using r for the radius of the earth regarded as constant,

$$\begin{aligned} -r \frac{d^2\theta}{dt^2} + r \sin\theta \cos\theta \left(2n + \frac{d\pi}{dt}\right) \frac{d\pi}{dt} &= \sin\theta P - \cos\theta \cos(nt + \varpi) Q - \cos\theta \sin(nt + \varpi) R \\ -r \sin\theta \frac{d^2\pi}{dt^2} - 2r \cos\theta \left(n + \frac{d\pi}{dt}\right) \frac{d\theta}{dt} &= \sin(nt + \varpi) Q - \cos(nt + \varpi) R. \end{aligned} \quad [8]$$

If the body be acted upon by a central force P at the surface, and ϱ be the distance in arc of the body from the center of force, and μ the angle which ϱ makes with the meridian reckoned from the south towards the east, if we put $n = 0$, we can change θ to ϱ and ϖ to μ in the preceding

equations, and thus deduce the equations of motion upon the spherical surface of the earth without rotation. Since gravity can produce no effect, the right member of the first equation becomes P , and of the second equation 0. Hence they become

$$\begin{aligned} r \frac{dd\varrho}{dt^2} &= r \sin \varrho \cos \varrho \frac{d\mu^2}{dt^2} - F \\ r \sin \varrho \frac{dd\mu}{dt^2} &= -2r \cos \varrho \frac{d\varrho}{dt} \cdot \frac{d\mu}{dt} \end{aligned} \quad [9]$$

If to the right-hand members of these equations we add the forces arising from the terms in the preceding equations containing n , resolved in the direction of ϱ and perpendicular to it, and expressed in terms of ϱ and μ instead of θ and ϖ , we shall have the equations of the motion of a body upon the elliptical surface of the earth with a rotatory motion, disregarding effects of the order of the earth's ellipticity. The equations will then become

$$\begin{aligned} r \frac{dd\varrho}{dt^2} &= r \sin \varrho \cos \varrho \frac{d\mu^2}{dt^2} + 2r \sin \varrho \cos \vartheta n \frac{d\mu}{dt} - F \\ r \sin \varrho \frac{dd\mu}{dt^2} &= -2r \cos \varrho \frac{d\varrho}{dt} \cdot \frac{d\mu}{dt} - 2r \cos \vartheta n \frac{d\varrho}{dt} \end{aligned} \quad [10]$$

If in these equations we put $F = 0$, they become the equations of the motion of a body when it is not acted upon by any superficial or tangential forces. If in these equations we then put $\frac{d\varrho}{dt} = 0$ and $\frac{dd\varrho}{dt^2} = 0$, the last equation, regarding $\cos \theta$ constant, gives $\frac{d\mu}{dt} = m$, a constant, which is the initial angular velocity. This value, substituted in the first equation, satisfies it when $\cos \varrho m = -2 \cos \theta n$. [11]

When ϱ is small, $\cos \varrho$ may be put $= 1$. Hence when the range of motion is so small in comparison with the radius of the earth, that $\cos \theta$ may be regarded as a constant, these equations may be satisfied with a motion in the circumference of a circle of which the angular velocity m is uniform, and equal to twice the velocity of the earth's rotation multiplied by the sine of the latitude. Since the value of m is negative in the northern hemisphere and positive in the southern, this motion is from left to right in the former, and the contrary in the latter.

Since ϱ , when it is so small that $\cos \varrho$ may be put $= 1$, does not enter into the preceding equation, it depends for its value upon the initial linear velocity. Multiplying both members of the preceding equation by $r \sin \varrho$, and putting $r \sin \varrho = \varrho' =$ the linear distance, $\cos \varrho = 1$, and $r \sin \varrho m = v =$ the initial linear velocity, we obtain

$$v = -2 \varrho' \cos \theta n. \quad [12]$$

Hence if a body receives a motion in any direction, it describes the circumference of a circle, if the range of motion is small, the radius of which is determined by the preceding equation; and the time of its performing a revolution is equal to the time of the earth's rotation divided by twice the sine of the latitude.

The time of revolution, in the latitude of Cambridge, is $16^h 15^m$; and if $v = 100$ feet per second, the radius is 176.3 miles.

From what precedes, it is evident that if a body is moving in any direction, there is a force, arising from the earth's rotation, which always deflects it to the right in the northern hemisphere, and to the left in the southern. Since this deflecting force must always be at right angles with the direction, it cannot change v the linear velocity; and hence when the range of motion is great, the radius of curvature is always inversely as the sine of the latitude. The larger the range of motion, the more it deviates from a circle; but the curve must always be symmetrical on each side of the central meridian, and the body return to the point from which it started.

Equations [10] may be applied to the motions of a pendulum in which the oscillations are small in comparison with its length. Putting $\varrho =$ the distance of the pendulum from its vertical position of rest, we may put $r \sin \varrho = \varrho$, $\cos \varrho = 1$, and $F = \frac{\varrho'g}{l}$, l being the length of the pendulum. These equations then become

$$\begin{aligned} \frac{dd\varrho'}{dt^2} &= \varrho \frac{d\mu^2}{dt^2} + 2\varrho \cos \theta n \frac{d\mu}{dt} - \frac{\varrho'g}{l} \\ \varrho \frac{dd\mu}{dt^2} &= -2\frac{d\varrho'}{dt} \cdot \frac{d\mu}{dt} - 2\cos \theta n \frac{d\varrho'}{dt} \end{aligned} \quad [13]$$

Putting $n = 0$, these equations become the differential equations of elliptic motion in which the body is attracted by a central force which varies as the distance. Hence the general motions of the pendulum, if the earth had no rotation, would be an ellipse of which the center would be the vertical position of the pendulum.

The preceding equations may be satisfied by the preceding motion in an ellipse which gyrates with an angular velocity m . The equations of such a motion are

$$\begin{aligned} \frac{dd\varrho'}{dt^2} &= \varrho \left(\frac{d\mu}{dt} - m \right)^2 - \frac{\varrho'g}{l} \\ \varrho \frac{dd\mu}{dt^2} &= -2\frac{d\varrho'}{dt} \left(\frac{d\mu}{dt} - m \right) \end{aligned} \quad [14]$$

If in these equations we put $m = -\cos \theta n$, they become the same as equations [13], omitting the very small term ϱm^2 in the first equation, which is of the order of the time of an oscillation compared with the time of the earth's rotation. Hence the general motion of a pendulum is in an ellipse, which, in the northern hemisphere, gyrates from left to right in the time of the earth's rotation divided by the sine of the latitude. Since the value of m is positive in the southern hemisphere, the gyration there is the contrary way.

The figure of this ellipse depends upon the initial value of $\frac{d\mu}{dt}$ and the initial direction of motion. If the initial direction is at right angles to ϱ , and such that $\left(\frac{d\mu}{dt} - m \right)^2 - \frac{g}{l} = 0$, the pendulum describes the circumference of a circle. If the initial value of $\frac{d\mu}{dt} = m$, equations [14] are reduced to

$$\frac{dd\rho'}{dt^2} = -\frac{\rho'g}{l}; \quad \frac{dd\mu}{dt^2} = 0. \quad [15]$$

The former is the equation of a simple pendulum vibrating in a right line; and the latter gives $\frac{d\mu}{dt} =$ a constant, which is its initial value m or $-\cos\theta n$. Hence, if the initial value of $\frac{d\mu}{dt} = -\cos\theta n$, the pendulum vibrates in a right line which performs a gyration in the same time and in the same manner as the ellipse in the more general case. If the pendulum receives no initial gyrotory motion, its vibrations deviate a little from a right line.

We have seen that a body cannot move in any direction without being deflected to the right in the northern hemisphere, and to the left in the southern. It cannot, therefore, be attracted or forced towards a center, without at the same time receiving a gyrotory motion around it. If, therefore, the lower strata of atmosphere flow in from all sides towards a center, on account of rarefaction produced by heat or any other cause, it must at the same time receive a gyrotory motion around that center; and this motion must be from right to left in the northern hemisphere, and the contrary in the southern. This completely accounts for the well established fact that the motion of storms is gyrotory; and that these gyrations, in the northern hemisphere, are always from right to left, and in the southern, from left to right.

The minimum amount of gyrotory motion for a given amount of motion towards the center may be deduced from the last of equations [10]. Omitting the first term of the right member, which is at first small, and putting $r \sin \rho \frac{d\mu}{dt} = v =$ the linear gyrotory velocity, $r \sin \rho = \rho' =$ the linear distance, considering $\sin \rho = \rho$ and $\cos \rho = 1$, we obtain

$$v = -2 \cos \theta n \rho' (\log \rho' - \log \rho''), \quad [16]$$

in which ρ'' is the value of ρ' at the commencement of motion.

If we suppose the atmosphere, at the distance of 200 miles on all sides from the center, to flow 50 miles towards it, the preceding equation gives about 15 miles per hour for the amount of gyrotory motion it must receive in that time, in the latitude of Cambridge, from the influence of the earth's rotation. A gyrotory motion being once produced, it is very rapidly accelerated, especially near the center, by the effect of the term which we have omitted, which then acquires a considerable value. This term is independent of the earth's rotation, and depends entirely upon the action of the central force.

We hope to be able to give a complete application of these principles to the theory of storms at some future time.

Cambridge, 1857 November 10.

ELEMENTS AND EPIHEMERIS OF THE SIXTH COMET OF 1857.

BY JAMES C. WATSON.

THE unfavorable state of the weather during the last two weeks having entirely prevented later observations of the new comet, discovered by VAN ARSDALE Nov. 10, I have computed, from observations made at Washington, Nov. 12, 15 and 17 (for which I am indebted to the kindness of Mr. FERGUSON), the following elements:

$$\begin{aligned} T &= 1857 \text{ Nov. } 16.985192 \text{ Washington M. T.} \\ \pi &= 45^\circ 53' 17.7 \\ \Omega &= 135^\circ 0' 36.7 \end{aligned} \left. \vphantom{\begin{aligned} T \\ \pi \\ \Omega \end{aligned}} \right\} \text{Mean Equinox } 1857.0$$

$$i = 37^\circ 44' 18.8$$

$$\log q = 0.004004$$

Motion retrograde.

The middle place is represented in the following manner:

$$\begin{aligned} &\text{Comp.} - \text{Obs.} \\ \Delta \epsilon \cos \delta &= -8''.2, \quad \Delta \delta = -49''.7 \end{aligned}$$

These elements give the following

Ephemeris for Washington Mean Midnight.

1857	$\angle \alpha$	$\angle \delta$	$\log \Delta$
Dec. 2	20 ^h 1 ^m 12 ^s	+17° 21.9	9.9988
3	4 54	16 9.7	
4	8 22	15 1.3	
5	11 37	13 56.6	
6	14 41	12 55.4	0.0477
7	17 34	11 57.4	
8	20 18	11 2.2	
9	22 53	10 9.9	
10	25 20	9 20.3	0.0928
11	27 40	8 33.1	
12	29 53	7 48.2	
13	32 0	7 5.4	
14	34 2	6 24.6	0.1341
15	35 59	5 45.7	
16	37 51	5 8.6	
17	39 39	4 33.1	
18	41 23	3 59.2	0.1712
19	43 4	3 26.8	
20	44 42	2 55.7	
21	20 46 17	+ 2 25.9	

Ann Arbor, 1857 Dec. 3.

JAMES C. WATSON.

LETTER FROM PROFESSOR WINLOCK TO THE EDITOR.

Office of American Ephemeris and Nautical Almanac, 1857 Dec. 21.

I WRITE to inform you of a very interesting relation between the mean motions of *Neptune*, *Uranus* and *Jupiter*, noticed by Mr. SIMON NEWCOMB, an assistant in this office.

If we assume the values of the mean motions in a Julian year as given in LE VERRIER'S *Annales de l'Observatoire*, &c., we shall find the following relation :

$$8n^{\text{viii}} + 3n^{\text{vii}} - n^{\text{v}} = +2.41;$$

and if, instead of these values of the mean motions, those are employed which are adopted in the *American Ephemeris*, the second member does not exceed 1'.

The coefficients of the terms of the perturbations which depend upon this angle are probably small, but their very long period entitles them to a careful examination.

JOSEPH WINLOCK.

LETTER FROM W. C. BOND, ESQ., TO THE EDITOR.

Observatory of Harvard College, Cambridge, 1858 January 7.

A FAINT telescopic comet was discovered at this Observatory on the evening of the 4th instant, by Mr. H. P. TUTTLE. Its position relative to a star of the 9 - 10 mag. was determined as follows :

$$\begin{array}{c} \nearrow \text{--- Star.} \\ \Delta\alpha = -0^{\text{m}} 6^{\text{s}}.72; \quad \Delta\delta = -5 \ 22 \ .7 \end{array}$$

The star of comparison (α) was subsequently compared with one of the 7 mag. (ϵ), as follows :

$$\begin{array}{c} \alpha - \epsilon \\ \Delta\alpha = +8^{\text{m}} 9^{\text{s}}.00; \quad \Delta\delta = +3 \ 4 \ .0 \end{array}$$

The star (ϵ) is found in Bessel's Zone 381, and in the *Histoire Celeste* (N^o 46436), giving the following places for 1858.0 :

Authority.	α	δ
Bessel's Zone 381	23 ^h 31 ^m 28 ^s .98	+39° 46' 16.6
Lalande, N ^o 46436	28.64	16.6

The apparent right-ascension and declination of the comet was :

Cambridge M. T.	$\nearrow \alpha$	$\nearrow \delta$
Jan. 4 9 ^h 31 ^m 55 ^s .8	23 ^h 42 ^m 30 ^s .30	+39° 44' 9 .1
Daily motion in right-ascension	+4 ^m .1	
" " declination	-50	

The comet was first seen at 7^h 30^m. It is rather faint, but not so much so as to afford any difficulty in observing it with the great refractor.

W. C. BOND.

LETTERS FROM C. W. TUTTLE, ESQ., TO THE EDITOR.

LETTER I.

Newburyport, 1857 Dec. 17.

I HEREWITH send you the following approximate elements of Comet 1857 VI, computed from observations made at the Harvard College Observatory on the 11, 17 and 20 Nov.

$$\begin{array}{ll} T = 1857 \text{ Nov. } 24 & 35937 \text{ Greenwich M. S. T.} \\ \pi = 40^{\circ} 9' 34'' & \\ Q = 153 \ 18 \ 41 & \left. \begin{array}{l} \\ \\ \end{array} \right\} \text{Mean Equinox 1857.0} \\ i = 38 \ 56 \ 16 & \\ \log q = 0.00069 & \end{array}$$

Motion Retrograde.

C. W. TUTTLE.

LETTER II.

Newburyport, 1858 Jan. 20.

I HAVE derived the following elements of the First Comet of 1858 from observations made at the Harvard Observatory. Jan. 4, 7 and 12.

$$\begin{array}{ll} T = 1858 \text{ Feb. } 19.97775 & \text{Greenwich M. T.} \\ \pi = 108^{\circ} 14' 28'' & \\ Q = 266 \ 7 \ 6 & \\ i = 57 \ 13 \ 32 & \\ \log q = 0.02951 & \end{array}$$

Motion Direct.

These elements satisfy the middle place as follows :

$$(C-O) \Delta\alpha = -46''; \quad \Delta\delta = -29''$$

C. W. TUTTLE.

The last-mentioned elements bear so strong a resemblance to those of the Second Comet of 1790, that there would seem to be small reason for doubt of the identity of the comet.

G.

NEW WORKS.

1. *A System of Analytic Mechanics*, by BENJAMIN PEIRCE.
Boston, 1855.

This beautiful volume forms the first of a series of four which its gifted author proposes to issue under the common title: *Physical and Celestial Mechanics, developed in four systems of Analytic Mechanics, Celestial Mechanics, Potential Physics, and Analytic Morphology*.

Though it bears upon its titlepage the date of 1855, in which year the first sheets were struck off, it has only been issued in the last days of 1857. It is a work for which the scientific world may afford to have waited, containing as it does the complete formulas of Analytic Mechanics in their most general forms and particular applications, with full discussion of special methods and development of special forms of investigation. Among the more striking new points may be mentioned the development of the Theories of Potentials and of Characteristic Functions, the discussion of LAPLACE'S and LEGENDRE'S Functions, the Theory of Determinants, the Principle of the Last Multiplier and its application to LAGRANGE'S Canonical Forms, the investigation of sundry dynamic curves, and the condensed view of LAPLACE'S and HANSEN'S methods of Perturbations.

Professor PEIRCE says in the prefatory Advertisement :

"I have examined the memoirs of the great geometers, and have striven to consolidate their latest researches and their most exalted forms of thought into a consistent and uniform treatise. If I have, hereby, succeeded in opening to the students of my country a readier access to these choice jewels of intellect, if their brilliancy is not impaired in this attempt to reset them, if in their new constellation they illustrate each other and concentrate a stronger light upon the names of their discoverers, and, still more, if any gem which I may have presumed to add is not wholly lustreless in the collection, I shall feel that my work has not been in vain. The treatise is not, however, designed to be a mere compilation. The attempt has been made to carry back the fundamental principles of the science to a more profound and central origin, and thence to shorten the path to the most fruitful forms of research. It has, moreover, been my chief object to develop the special forms of analysis, which are usually neglected, because they are only applicable to particular problems, and to restore them to their true place in the front ranks of scientific progress. The methods which, on account of their apparent generality, have usually attracted the almost exclusive attention of the student, are, on the contrary, reestablished in their true position as higher forms of speciality."

Appended is a table of the chapters and their contents :

CHAPTER I. Motion, Force and Matter.

- " II. Measure of Motion and Force.
- " III. Fundamental Principles of Rest and Motion.
- " IV. Elements of Motion.
- " V. Forces of Nature.
- " VI. Equilibrium of Translation.
- " VII. Equilibrium of Rotation.
- " VIII. Equilibrium of Equal and Parallel Forces.
- " IX. Action of Moving Bodies.
- " X. Integration of the Differential Equations of Motion.
- " XI. Motion of Translation.
- " XII. Motion of Rotation.
- " XIII. Motion of Systems.

APPENDIX : *Note A*. On the force of moving bodies.

" *B*. On the theory of orthographic projections.

2. *Tables de la Lune, construites d'après le Principe Newtonien de la gravitation universelle*, par P. A. HANSEN, Directeur de l'Observatoire ducal de Gotha. Imprimé aux frais du Gouvernement Britannique, 1857. pp. 511.

This long-expected and earnestly desired work has at length been issued, in a beautiful dress similar to that of the Greenwich Observations and Planetary Reductions. It is dedicated by the Author to the Lords Commissioners of the British Admiralty, by whose aid the computations were completed and the classic work given to astronomers, and by whom it has been distributed with distinguished liberality under the direction of the Astronomer Royal.

The book begins with 74 pages of explanation, giving the formulas employed, the mode of construction and directions for use; the tables themselves occupying the remaining 440. The inequalities of the mean anomaly are first computed by means of thirty tables with double argument and twenty-three single-argument tables, eight preliminary ones furnishing the arguments therefor. All these are comprised under the title: "*Argument Fondamental*", which is the perturbed mean anomaly, this constituting in its turn the argument for finding the perturbed true anomaly; the method of Prof. HANSEN being, as is well known, based upon the introduction of a disturbed time. All the arguments for obtaining the inequalities of the mean anomaly are expressed in days.

Under the title "*Longitude Vraie*" we find eleven tables giving ϖ , the distance of the perigee from the ascending node; *II*, the tropical longitude of the perigee; *R*, the reduction to the ecliptic, and four tables containing the inequalities of *R*. The perturbed true anomaly being *f*, the reduction *R* is obtained from argument $f + \varpi$.

Next we have tables for the *Parallax*, nineteen in all;

fourteen of these being tables of double argument, and all the arguments being identical with the corresponding ones used for deducing the inequalities of the mean anomaly. Besides these, there are two additional parallax-tables; the one having for its argument the perturbed mean anomaly, and the other serving for the transformation of the parallax from sine to arc.

The *latitude* is found from the formula

$$\sin \text{latitude} = \sin I \sin (f + \varpi) + s$$

in which I is the inclination of the lunar orbit to the true ecliptic, and s the inequality of the sine of the latitude; the latter being found by means of thirty-two tables, eighteen of which are with double arguments.

The volume ends with tables for converting longitudes and latitudes into right-ascensions and declinations, intended to abridge the labor of this conversion. Of this no one can be a better judge than Professor HANSEN himself; and with the expansion and minuteness which he has given to the tables, he expresses his confidence that they will be found highly convenient for use.

The values of the constants adopted by Professor HANSEN are given by him in an extended "Letter to the Astronomer Royal", published in the *Monthly Notices* of the Royal Astronomical Society (Vol. xv, p. 1, 1854 Nov. 10); in which letter he gives a full account of the principles adopted in the construction of these tables, and their comparison with Greenwich Observations in years ranging from 1824 to 1850. The adopted precession is

$$50''.2230(t-1800) + 1''.121 \frac{(t-1800)^2}{100},$$

and the sidereal motion of the solar perigee,

$$+ 11''.3618(t-1800) + 0''.550 \left(\frac{t-1800}{100} \right)^2.$$

The coefficient of tropical secular acceleration is $13''.30$, including the $1''.21$ due to the secular acceleration of the precession. Professor AIRY has since, from an investigation of three ancient eclipses (those of Agathocles, Larissa and Thales) and the path of the shadow in the eclipse at Stiklastad, computed by means of HANSEN's tables themselves, deduced a new value of this coefficient differing from Professor HANSEN's by about $0''.755$. Increasing the Hansenian value by this quantity, and the argument of latitude by $45''$ multiplied by the number of centuries before 1800, the four eclipses are brought into perfect harmony. (*Monthly Notices*, 1857 July 10, xvii, 255.)

The inequalities of the longitude are given in decimals of a degree, the unit of the tables being the seventh decimal; those of the parallax and latitude are given in minutes and seconds.

HANSEN's discovery, now familiar to all, that the moon's center of gravity does not coincide with its center of figure, was announced in the letter to AIRY cited above. The theorem which he announced was the following:—

"If the center of gravity of the moon and the center of its figure do not coincide, then must all the coefficients of perturbation for the mean longitude be multiplied by a constant factor, which is a function of the distance between these two centers projected upon the radius vector. If the center of the moon be farther removed from us than the center of gravity, then is this factor less than unity; but if, on the contrary, the former be nearer to us than the latter, the factor will be greater than unity."

Discussion of both the Greenwich and the Dorpat observations, with reference to this point, showed conclusively that this factor was greater than unity; and HANSEN's final determination gave it as 1.0001544: whence "there results, among other consequences, an enlargement of the coefficient of the evection equal to $0''.69$, and it is easily recognized that the enlargement of the sum of all the perturbations may exceed $1''$."

"From the above-cited value of the factor, it follows that the center of the moon's figure lies about 59000 meters [about 36 statute or 32 geographical miles] nearer to us than the center of gravity."

3. *Theory of the Motion of the Heavenly Bodies moving about the Sun in Conic Sections: a translation of GAUSS's Theoria Motus*. With an Appendix, by C. H. DAVIS. Boston, 1857. pp. 326, and Tables, pp. 36.

The rarity of GAUSS's original work and the diminished employment of the Latin in scientific treatises combined to induce Captain DAVIS, late Superintendent of the American Nautical Almanac, to undertake its translation into English, which was begun several years since; and the present elegant edition is printed by the joint contributions of the Nautical Almanac fund and Smithsonian Institution. The formulas in the body of the work have been examined with great care by Professor CHAUVENET, not only by comparison with the original, but by independent verification, resulting in the detection of a considerable number of *corrigenda*, in addition to those heretofore published. These are appended to the present notice. The translation was subsequently read with care by Professor PHILLIPS of Chapel Hill (N.C.) and Mr. RUNKLE of the Nautical Almanac Office, and finally revised by Professor WINLOCK, Superintendent of the Almanac.

The Appendix contains the results of the investigations of Professors ENCKE and PEIRCE upon the exceptional case of a twofold determination of the orbit from the same three geocentric places; and Professor PEIRCE's Graphic Delineations of the curves, showing geometrically the roots of GAUSS's Equations IV, Article 141. Also a table for the Motion in a Parabola, from the first volume of the *Annals of the Imperial Observatory of Paris*, being an improved form of the table given in DELAMBRE's *Astronomy*; BESSEL's and POSSELT's

tables (*Monatl. Corresp.* XII. 197; *Zeitschr. für Astron.* v. 161) for ellipses and hyperbolas closely resembling the parabola: a convenient table, by Professor HUBBARD, for facilitating the use of GAUSS's formulas for ellipses and hyperbolas whose eccentricities are nearly equal to unity; sundry formulas, by various astronomers, which illustrate the text; and

ENCKE's summary of the formulas for computing the orbit of a comet: thus making the book a complete storehouse of all the tables and formulas necessary in the computations of theoretical astronomy.

Appended are the errors detected in the original edition of the *Theoria Motus*.

CORRIGENDA IN GAUSS'S *THEORIA MOTUS*,

NOT MENTIONED IN THE ORIGINAL WORK.

Page	Line	For	Read	Page	Line	For	Read
4	9	380° (in some copies only)	180°	129	— 1	after "quoties fuerit"; add " $B=B'=B''=0$ atique"	
• 10	3	log 206264.7	log 206264.8	* 131	13	art. 70	art. 71
14	18	IX	XI	* 139	14	art. 119	art. 120
19	10	$u = 0$	$u = 1$	147	— 11	$-e$	$+e$
30	8	$1 \pm 5e \omega \tan F$	$\omega \pm 5e \omega \tan F$	147	— 10	$-d$	$+d$
30	8	$1 + \frac{3e\omega}{\cos F}$	$\omega + \frac{3e\omega}{\cos F}$	151	1	$\alpha - \lambda$	$\alpha - l$
30	10	$1 \pm 3e \omega \tan F$	$\omega \pm 3e \omega \tan F$	151	3	$\alpha - \lambda$	$\alpha - l$
40	— 3	0.22926	0.022926	159	— 7	IV	III
59	— 3	$\frac{r'-R'}{r-R'}$	$\frac{r'+R'}{r'-R'}$	160	16	[17]	[18]
• 60	19	8.6290029 n	9.6290029 n	* 161	12	V	VI
65	2	$\cos \delta$	$\cos \zeta$	* 161	16	V	VI
• 67	— 3	0.66627 n	0.66636 n	* 161	22	VI vel cum IX	V vel cum VIII
• 67	— 1	$b = -15^\circ 49' 43''.86$	$b = -15^\circ 49' 48''.58$	162	1,2,3,4	ε	ε
• 68	1	0.66627 n	0.66636 n	* 170	— 14	$\log e = 8.3929518$	$\log e = 8.3929518 n$
• 68	5	5.48288 n	5.48297 n	* 171	20	9.8648511	9.8648551
72	14	28' 54	$L = 12^\circ 28' 54$	* 187	— 6	art. 142	art. 149
78	2	$\tan Q = \frac{\tan(N-b)}{\cos \omega \cos i}$	$\tan Q = \frac{\tan(N-b)}{\cos \omega \sin i}$	190	15	art. 147	art. 143
• 83	9	$\frac{b \cos(45^\circ + \zeta)}{\sin \zeta \sqrt{2}}$	$\frac{b \cos(45^\circ + \zeta)}{\cos \zeta \sqrt{2}}$	190	— 7	art. 146	art. 143
• 83	— 1	$\tan(\zeta - 45^\circ)$	$\cotan(\zeta - 45^\circ)$	193	— 6	ad	et
• 85	3	$\cotan \frac{1}{2}(B-A)$	$\cotan \frac{1}{2}(N-N')$	195	7	$+(n \text{ o } 2)$	$+(n \text{ o } 1)$
• 86	14	$\sin \frac{1}{2}(N+N'-H)$	$\sin(\frac{1}{2}N + \frac{1}{2}N' - H)$	195	18	$\cos \beta \sin(\alpha - \alpha')$	$\cos \beta \sin(\alpha - \alpha')$
87	14	affecti	affectæ	197	— 8	$Q'' = kk(t''-t')(t'''-t'')$	$Q'' = \frac{1}{2}kk(t''-t')(t'''-t'')$
• 93	20	$\log p = 0.3954807$	$\log p = 0.3954822$	201	— 10	$\log Q = 9.68097$	$\log Q = 9.67997$
97	— 8	$(1 - \frac{6}{5} \sin g^2)$	$(1 - \frac{6}{5} \sin \frac{1}{2} g^2)$	212	— 10	$\Delta \varnothing$	$\varnothing \Delta$
101	12	art. 89	art. 88	216	7	delete "quod"	
* 105	16	art. 89	art. 88	219	8	$\sqrt{A}, \sqrt{B'}, \sqrt{C''}, \sqrt{D''}$, etc.	$\frac{1}{\sqrt{A}}, \frac{1}{\sqrt{B''}}, \frac{1}{\sqrt{C''}}, \frac{1}{\sqrt{D''}}$
* 106	1	art. 87, 88	art. 86, 87	219	— 5	$+ 1173 R$	$+ 738 R$
114	2	$\sqrt{(L-z)}$	$\sqrt{(L+z)}$	220	5	$\sqrt{\frac{13266}{491}} = 5.20$	$\sqrt{\frac{2211}{41}} = 7.34$
* 116	12	YY	yy				
* 116	13	yy	YY				
116	— 2	art. 98	art. 99				
* 119	8	0.05336663	0.05536663				
* 121	— 3	$a-r, a-r'$	$2a-r, 2a-r'$				
126	— 4	$rr' \sin u \sin i$	$rr' \sin(u-u') \sin i$				

IN THE TABLES.

Table	Page	For	Read
* I	3, last line	0.200	0.300
II	10, $h = 0.0211$ in col. log yy	4601	6401
II	14, $h = 0.291$ " "	58019	58094
II	15	$h 0.347$	$h 0.473$

* These errors were detected by Professor CHAUVENET.

CONTENTS.

INFLUENCE OF THE EARTH'S ROTATION UPON THE RELATIVE MOTION OF BODIES NEAR ITS SURFACE, BY MR. W. FERREL.

ELEMENTS AND EPHEMERIS OF THE SIXTH COMET OF 1857, BY MR. JAMES C. WATSON.

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LETTER FROM W. C. BOND, ESQ., TO THE EDITOR.

TWO LETTERS FROM MR. C. W. TUTTLE TO THE EDITOR.

NOTICES OF NEW WORKS, WITH CORRIGENDA IN GAUSS'S *THEORIA MOTUS*

ALBANY: C. VAN BENTHUYSEN, PRINTER

THE ASTRONOMICAL JOURNAL.

No. 110.

VOL. V.

ALBANY, 1858, FEBRUARY 13.

NO. 14.

OBSERVATIONS OF ALGOL-MINIMA.

MADE AT WELD, FRANKLIN COUNTY, MAINE.

BY STILLMAN MASTERMAN.

In computing the time of minimum from my observations, I make use of all the comparisons for the space of half an hour before and after the final mean of the entire observations.

1857 SEPTEMBER 11.

It was very clear at commencement of observations: but approaching haziness rendered the last comparison difficult and unreliable.

Watch-time.	COMPARISON.					
	δ		ρ		*	
11 ^h 36 ^m	ρ	1 δ	ρ	3 ρ	ρ	1 *
42		1		2 $\frac{1}{2}$	=	
48		$\frac{1}{2}$		2 $\frac{1}{2}$	ρ	= *
54		=		2	*	1 ρ
12 0	ρ	= δ		1 $\frac{1}{2}$		1
6	δ	1 ρ		1	2	
12		1		$\frac{1}{2}$	2	
18		1 $\frac{1}{2}$		$\frac{1}{2}$	2	
24		2		=	3	
30		2		=	3	
36		1 $\frac{1}{2}$		$\frac{1}{2}$	2	
42		1		1	2	
48		1		1	1	
12 54	δ	= ρ	ρ	1 $\frac{1}{2}$ ρ	*	1 ρ

Observed Time of Minimum.

By comparison with δ :

$$\left. \begin{array}{l} 12^h 27^m 00 \\ 27.00 \end{array} \right\} 12^h 27^m 00 \\ 12 27.00 \text{ (Weight 1)}$$

With ρ :

$$\left. \begin{array}{l} 12^h 25^m 50 \\ 25.50 \end{array} \right\} 12^h 26^m 00 \\ 12 27.00 \text{ (Weight 2)}$$

With * :

$$\left. \begin{array}{l} 12^h 22^m 50 \\ 25.50 \end{array} \right\} 12^h 25^m 00 \\ 12 27.00 \text{ (Weight 1)}$$

Final mean 12^h 26^m 00

Correction for watch-error — 0.86

12 25.14

Longitude east from Washington, ... 26.65

Observed minimum, Sept. 11 11 58.49 Wash. M. T.

1857 OCTOBER 4.

The sky was very clear, and the moonlight bright.

Watch-time.	COMPARISON.					
	δ		ρ		*	
9 ^h 50 ^m	ρ	1 δ	ρ	3 ρ	ρ	1 *
9 56		1		3		1
10 2		$\frac{1}{2}$		2 $\frac{1}{2}$		=
8		=		2	ρ	= *
14	ρ	= δ		1 $\frac{1}{2}$	*	1 ρ
20	δ	1 ρ		1 $\frac{1}{2}$		1
26		1		1		1
32		1		1		1 $\frac{1}{2}$
38		1 $\frac{1}{2}$		1		2
44		2		$\frac{1}{2}$		2
50		2		$\frac{1}{2}$		2 $\frac{1}{2}$
10 56		2		$\frac{1}{2}$		2 $\frac{1}{2}$
11 2		2		$\frac{1}{2}$		2
8		1 $\frac{1}{2}$		1		1 $\frac{1}{2}$
14		1 $\frac{1}{2}$		1		1 $\frac{1}{2}$
20		1		1 $\frac{1}{2}$		1 $\frac{1}{2}$
26		1		1 $\frac{1}{2}$		1
32		=		2		1
38	δ	= ρ		2		1
44	ρ	$\frac{1}{2}$ δ		2 $\frac{1}{2}$		=
50		$\frac{1}{2}$		2 $\frac{1}{2}$		=
11 56		1		3	*	= ρ
12 2	ρ	1 δ	ρ	3 ρ	ρ	1 *

*Observed Time of Minimum.*By comparison with δ :

$$\begin{array}{l} 10^h 51^m 50 \\ 51.50 \\ 10 53.00 \end{array} \left. \vphantom{\begin{array}{l} 10^h 51^m 50 \\ 51.50 \\ 10 53.00 \end{array}} \right\} \begin{array}{l} 10^h 54^m 00 \\ \text{(Weight 1)} \end{array}$$

With ρ :

$$\begin{array}{l} 10^h 50^m 00 \\ 51.50 \\ 10 53.00 \end{array} \left. \vphantom{\begin{array}{l} 10^h 50^m 00 \\ 51.50 \\ 10 53.00 \end{array}} \right\} \begin{array}{l} 10^h 51^m 50 \\ \text{(Weight 2)} \end{array}$$

With $*$:

$$\begin{array}{l} 10^h 53^m 00 \\ 51.50 \\ 10 53.00 \end{array} \left. \vphantom{\begin{array}{l} 10^h 53^m 00 \\ 51.50 \\ 10 53.00 \end{array}} \right\} \begin{array}{l} 10^h 52^m 50 \\ \text{(Weight 1)} \end{array}$$

Final mean $10^h 52^m 37$ Correction for watch-error $- 1.12$ $10 51.25$ Longitude east from Washington, 26.65 Observed minimum, Oct. 4. . . . $10 24.60$ Wash. M. T.

1857 OCTOBER 21.

Clear and cool.

Watch-time.	COMPARISON.		
	δ	ρ	$*$
$15^h 12^m$	$\delta = \beta$	$\beta 3 \rho$	$* = \beta$
18	1	$2\frac{1}{2}$	1
24	1	$2\frac{1}{2}$	1
30	$1\frac{1}{2}$	2	2
36	2	1	2
42	2	$\frac{1}{2}$	3
48	2	$\frac{1}{2}$	3
15 54	2	$\frac{1}{2}$	3
16 0	$1\frac{1}{2}$	1	3
6	1	2	2
12	1	2	2
18	1	$2\frac{1}{2}$	2
24	=	$2\frac{1}{2}$	1
16 30	$\delta = \beta$	$\beta 3 \rho$	$* 1 \beta$

*Observed Time of Minimum.*By comparison with δ :

$$\begin{array}{l} 15^h 46^m 50 \\ 45.00 \\ 15 45.00 \end{array} \left. \vphantom{\begin{array}{l} 15^h 46^m 50 \\ 45.00 \\ 15 45.00 \end{array}} \right\} \begin{array}{l} 15^h 45^m 50 \\ \text{(Weight 1)} \end{array}$$

With ρ :

$$\begin{array}{l} 15^h 51^m 00 \\ 49.50 \\ 48.00 \\ 15 48.00 \end{array} \left. \vphantom{\begin{array}{l} 15^h 51^m 00 \\ 49.50 \\ 48.00 \\ 15 48.00 \end{array}} \right\} \begin{array}{l} 15^h 49^m 13 \\ \text{(Weight 2)} \end{array}$$

With $*$:

$$\begin{array}{l} 15^h 52^m 50 \\ 15 51.00 \end{array} \left. \vphantom{\begin{array}{l} 15^h 52^m 50 \\ 15 51.00 \end{array}} \right\} \begin{array}{l} 15^h 51^m 75 \\ \text{(Weight 1)} \end{array}$$

Final mean $15^h 48^m 88$ Correction for watch-error $- 1.08$ $15 47.80$ Longitude east from Washington, 26.65 Observed minimum, Oct. 21 . . . $15 21.15$ Wash. M. T.

NOTE. ρ Persei appears at times nearly as measure brighter than β at the minimum of the latter, and at other times somewhat fainter than the minimum brightness of this star. At the minimum of 1856 Dec. 7, ρ was decidedly brighter than Algol ; while at the minima of 1857 Oct. 4 & 21, my observations make it less in brightness than the least intensity of light in β . At the minimum of 1858 Jan. 1, ρ , according to my determination, was a trifle brighter than Algol .

1857 NOVEMBER 10.

The sky was very clear; but twilight rendered the last comparisons somewhat difficult.

Watch-time.	COMPARISON.			
	δ	ρ	$*_1$	$*_2$
$16^h 40^m$	$\delta = \rho$	$\beta 3 \rho$		
44			$*_1 1 \beta$	$\beta 4 *_2$
48	1	$2\frac{1}{2}$		
52			$1\frac{1}{2}$	3
16 56	1	$2\frac{1}{2}$		
17 0			2	3
4	2	2		
8			2	2
12	$2\frac{1}{2}$	1		
16			3	2
20	3	$\frac{1}{2}$		
24			$3\frac{1}{2}$	1
28	3	=		
32			$3\frac{1}{2}$	1
36	3	=		
40			3	2
44	$2\frac{1}{2}$	$\frac{1}{2}$		
48			2	3
52	2	1		
17 56			2	3
18 0	2	2		
4			$*_1 2 \beta$	$\beta 3 *_2$
18 8	$\delta 1 \rho$	$\beta 2\frac{1}{2} \rho$		

*Observed Time of Minimum.*By comparison with δ :

$$\begin{array}{l} 17^h 30^m 00 \\ 28.00 \\ 17 28.00 \end{array} \left. \vphantom{\begin{array}{l} 17^h 30^m 00 \\ 28.00 \\ 17 28.00 \end{array}} \right\} \begin{array}{l} 17^h 28^m 67 \\ \text{(Weight 1)} \end{array}$$

With ρ :

$$\begin{array}{l} 17^h 32^m 00 \\ 32.00 \\ 32.00 \\ 17 32.00 \end{array} \left. \vphantom{\begin{array}{l} 17^h 32^m 00 \\ 32.00 \\ 32.00 \\ 17 32.00 \end{array}} \right\} \begin{array}{l} 17^h 32^m 00 \\ \text{(Weight 2)} \end{array}$$

With $\ast_1$:		Final mean	17 ^h 29 ^m .47
17 ^h 28 ^m .00 } 17 ^h 28 ^m .00		Correction for watch-error . . .	+ 0.75
28.00 } (Weight 1)			17 30.22
17 28.00 }			
With $\ast_2$:		Longitude east from Washington,	26.65
17 ^h 26 ^m .00 } 17 ^h 26 ^m .67		Observed minimum, Nov. 10 . .	17 3.57 Wash. M. T.
26.00 } (Weight 1)			
17 28.00 }			

DETERMINATION OF THE ORBIT OF THALIA.

BY ERNEST SCHUBERT.

[Communicated by Prof. WINLOCK, Superintendent American Ephemeris.]

ACCORDING to my promise given in my report to you on the determination of the orbit of *Thalia*, published in N° 100 of the *Astronomical Journal*, I have now derived a fifth normal-place from eight Berlin observations, namely :

1856 Oct. 16.5 Berlin M. T. α δ
 25° 31' 59".32 — 1° 49' 43".36 referred to the mean equinox 1854 Jan. 0.

This gives two additional equations of condition :

$$\begin{aligned} 0 &= -1416.35 + 1.38732 dM - 2.77798 d\varphi + 1.40025 d\pi + 0.07370 d\Omega + 0.54347 di + 14.37670 (100) d\mu \\ 0 &= -731.58 + 0.73561 - 1.49560 + 0.76603 - 0.18694 - 0.98968 + 7.30793; \end{aligned}$$

and the six final equations derived from the ten equations of condition become

$$\begin{aligned} +11.31628 dM - 8.65746 d\varphi + 10.42277 d\pi - 0.19024 d\Omega + 0.05065 di + 10.39224 (100) d\mu - 2923.922 &= 0 \\ - 8.65746 + 30.67899 - 6.35784 + 0.09652 - 0.10088 - 13.34923 + 5123.186 &= 0 \\ +10.42277 - 6.35784 + 10.24511 - 0.17512 + 0.01443 + 19.83544 - 3182.587 &= 0 \\ - 0.19024 + 0.09652 - 0.17512 + 0.24259 + 0.10904 - 0.18193 + 45.521 &= 0 \\ + 0.05065 - 0.10088 + 0.01443 + 0.10904 + 3.07832 + 0.72172 - 57.780 &= 0 \\ +10.39224 - 13.34923 + 19.83544 - 0.18193 + 0.72172 + 382.01230 - 27908.394 &= 0 \end{aligned}$$

$$[ns] = -28903.97, [as] = +23.33417, [bs] = +2.31029, [cs] = +33.9848, [ds] = -0.09916, [es] = +3.87330, [fs] = +399.4310.$$

Whence the corrections of the elements

$$\begin{array}{cccccc} dM & d\varphi & d\pi & d\Omega & di & d\mu \\ +199''.42 & -98''.77 & -86''.51 & -1''.38 & -3''.40 & +0''.68677, \end{array}$$

which are almost identical with those obtained from only the first four normals. These were

$$+200.78 \quad -98.89 \quad -87.85 \quad -4.60 \quad -5.08 \quad +0.68823.$$

This shows that an accurate determination of the orbit has been attained.

The perturbations by $\mathcal{U}$ and $\mathcal{h}_2$, from 1854.0 to 1856 Oct. 16.5, are

$$\begin{array}{ccc} x - x^0 & y - y^0 & z - z^0 \\ +176253 & -28363 & -19517. \end{array}$$

With the above new corrections, we have

CORRECTED ELEMENTS OF *THALIA*.

1854 Jan. 0.0 Berlin M. T.

$$\begin{array}{l} M = 50^\circ 28' 14.82 \\ \pi = 123^\circ 11' 26.89 \\ \Omega = 67^\circ 55' 58.22 \\ i = 10^\circ 13' 52.90 \\ \varphi = 13^\circ 35' 52.33 \\ \mu = 834.29137 \\ \log \mu = 2.9213177 \\ \log a = 0.4191259; \end{array} \quad \text{M. Eq. Epoch.}$$

by which the five normals are represented thus :

$$\begin{array}{cc} \mathcal{A}a \cos \delta & \mathcal{A}\delta \\ " & " \\ +0.58 & -0.75 \\ -0.64 & +1.93 \\ +1.02 & +2.03 \\ -0.03 & -0.62 \\ -1.05 & +2.07 \end{array}$$

EPIHEMERIS OF *THULLA* FOR THE OPPOSITION IN 1859.*Mean Washington Midnight.*

1859	α	δ	$\log \Delta$	$\log r$	1859	α	δ	$\log \Delta$	$\log r$
	^h ^m ^s	[°] ['] ^{''}				^h ^m ^s	[°] ['] ^{''}		
June 5	19 53 18.51	-29 8 13.3	0.368304	0.503349	July 12	19 22 43.12	-32 1 30.7	0.342276	
6	52 19.06	13 42.2	366800		13	21 42.16	1 52.2	342578	0.507103
7	52 18.17	18 13.2	365328	503580	14	20 41.30	8 7.0	342936	
8	51 15.85	23 45.8	363890		15	19 40.59	11 11.8	343350	507264
9	51 12.12	28 49.9	362487	503807	16	18 40.10	14 15.8	343819	
10	50 37.00	33 55.2	361121		17	17 39.89	17 9.8	344344	507422
11	50 0.52	39 1.4	359793	504030	18	16 40.01	19 56.7	344922	
12	49 22.67	44 8.1	358503		19	15 40.52	22 36.5	345555	507576
13	48 43.48	49 15.8	357253	504249	20	14 41.48	25 9.3	346241	
14	48 2.97	54 23.5	356045		21	13 42.94	27 34.9	346980	507727
15	47 21.18	29 59 31.2	354878	504465	22	12 44.96	29 53.3	347772	
16	46 38.13	30 4 38.6	353754		23	11 47.59	32 4.3	348616	507874
17	45 53.85	9 45.3	352675	504677	24	10 50.91	34 8.1	349511	
18	45 8.37	14 51.2	351640		25	9 54.94	36 4.7	350457	508017
19	44 21.72	19 55.9	350651	504885	26	8 59.74	37 54.1	351452	
20	43 33.93	24 59.2	349709		27	8 5.36	39 36.3	352497	508156
21	42 45.03	30 1.0	348814	505089	28	7 11.87	41 11.5	353590	
22	41 55.04	35 0.9	347967		29	6 19.30	42 39.6	354730	508292
23	41 4.02	39 58.7	347170	505291	30	5 27.71	44 0.6	355917	
24	40 12.01	44 54.1	346425		31	4 37.13	45 14.8	357149	508425
25	39 19.04	49 46.7	345731	505489	Aug. 1	3 47.63	46 22.2	358425	
26	38 25.16	54 36.3	345088		2	2 59.25	47 22.8	359746	508555
27	37 30.42	30 59 22.5	344497	505683	3	2 12.01	48 16.8	361109	
28	36 31.87	31 4 5.2	343960		4	1 25.95	49 4.1	362513	508681
29	35 38.58	8 44.0	343478	505874	5	19 0 41.11	49 44.9	363957	
30	34 41.58	13 18.6	343050		6	18 59 57.53	50 19.4	365439	508803
July 1	33 43.94	17 48.9	342676	506060	7	59 15.23	50 47.8	366960	
2	32 45.69	22 11.6	342358		8	58 34.26	51 10.1	368516	508922
3	31 46.91	26 35.5	342095	506243	9	57 54.64	51 26.6	370107	
4	30 47.63	30 51.3	341889		10	57 16.38	51 37.6	371732	509036
5	29 47.92	35 1.8	341739	506421	11	56 39.50	51 43.0	373391	
6	28 47.81	39 6.8	341616		12	56 4.03	51 42.8	375081	509148
7	27 47.48	43 6.1	341609	506597	13	55 29.98	51 37.1	376802	
8	26 46.87	46 59.5	341629		14	54 57.36	51 26.2	378553	509255
9	25 46.07	50 46.9	341706	506769	15	54 26.17	51 10.4	380332	
8 10	24 45.14	54 28.0	341840		16	18 53 56.41	-32 50 49.5	0.382139	0.509359
11	19 23 11.14	-31 58 2.7	0.342030	0.506938					

2 1859 July 10, 8^h 7^m 8^s.0 Washington M. T. Intensity of light = 0.365. r is the undisturbed radius-vector in the ellipse 1854 Jan. 0.0

OBSERVATIONS OF THETIS, CIRCE, IRENE, VIRGINIA, AND THE 47th ASTEROID.

MADE WITH THE FILAR MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Lieutenant MAURY.—Corrected for refraction.]

THETIS.

Date	M. T. Washington.	No. Comp.	Comparison-Star	$\Delta\alpha$	$\Delta\delta$	α	δ
	^h ^m ^s			^m ^s	['] ^{''}	^h ^m ^s	[°] ['] ^{''}
1857 Sep. 6	10 2 57.5	10	Weisse O. 434	+1 40.37	-10 7.51	0 27 37.94	- 4 47 59.16
8	9 1 10.4	12	" 137	-0 0.68	-13 23.62	0 26 10.01	5 2 53.52
17	9 47 4.4	9	" 236	+3 53.78	-11 21.67	0 18 51.06	6 10 3.73
23	9 28 55.5	8	" 172	+3 7.83	+ 3 34.93	0 13 41.48	6 52 54.02
24	8 23 41.1	10	" 172	+2 17.79	- 2 55.10	0 12 51.44	6 59 24.05
25	8 45 35.2	16	" 172	+1 24.42	- 9 39.69	0 11 58.07	- 7 6 8.65

Adopted Mean Places for 1860.0 of Comparison-Stars.

*	Mag.	α			Authority	δ	Authority
		h	m	s			
Weisse O. 434	7	0	26	3.38	Weisse's Catalogue.	— 4 37 15.82	Y. 3.
.. 437	8	0	26	16.48		4 48 53.81	Y. 1.
.. 236	7	0	15	5.92		5 58 5.61	Y. 3.
.. 172	8	0	10	39.22		— 6 55 52.31	Y. 3.

* This star is 414 of LALANDE. The α in WEISSE is one minute too small.

VIRGINIA.

Date.	Washington M T	No. Comp.	Comparison-Star	50 — *		50's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1857 Oct. 29	9 27 50.7	6	Rümker, N. F. 340	—0 3.90	—19 12.26	0 43 43.19	+ 1 39 15.04
29	9 46 35.8	5	* 4	—0 28.22	+ 1 58.42	0 43 42.85	1 39 9.32
Nov. 2	9 16 43.6	8	Weisse O. 678	+3 12.00	— 7 17.02	0 42 11.22	1 27 38.93
3	10 5 48.1	10	..	+3 1.28	— 9 27.49	0 42 30.19	1 25 28.13
4	8 22 16.8	10	..	+2 52.17	—11 34.23	0 42 21.38	1 23 21.64
7	7 36 50.8	10	..	+2 34.94	—16 11.26	0 42 4.15	1 18 44.49
10	8 56 12.5	6	..	+2 34.04	—18 38.44	0 42 3.24	1 16 17.19
11	9 14 44.1	6	..	+2 37.57	—19 0.05	0 42 6.76	1 15 55.52
14	9 2 13.1	6	..	+2 59.96	—18 23.69	0 42 29.14	1 16 31.77
25	8 9 51.1	6	* 4	+2 1.07	— 0 21.20	0 46 12.03	1 36 48.37
25	8 5 26.0	5	* 5	—2 0.37	+ 5 11.10	0 46 12.03	1 36 48.51
Dec. 1	8 36 18.1	6	* 6	—0 7.45	— 1 21.84		
		6	* 7	—0 56.06	+15 59.42	0 49 45.50	1 59 9.10
3	8 15 24.4	10	Weisse O. 902	—0 58.28	—10 54.37	0 51 8.51	2 8 10.41
7	8 14 48.8	6	.. 912	+1 39.55	— 3 59.08	0 54 14.97	2 28 15.71
10	8 18 29.2	10	.. 979	+0 42.93	+15 36.63	0 56 50.40	2 45 41.88
12	8 16 38.0	13	.. 1048	—0 53.33	— 5 59.24	0 58 40.40	2 57 8.55
13	8 19 54.1	8	.. 1048	+0 3.88	+ 0 19.71	0 59 37.60	3 3 27.43
15	8 13 23.2	16	.. 1048	+2 1.17	+13 14.24	1 1 34.87	3 16 21.83
18	7 35 43.1	21	Rümker N. F. 538	+0 33.75	— 3 55.40	1 4 41.73	3 36 32.15
20	7 28 26.7	1	.. 559	—0 31.80	+ 0 7.04	1 6 52.48	3 50 48.81
23	8 2 9.3	6	.. 572	+0 55.85	— 5 12.72	1 10 18.38	4 13 9.95
23	9 1 13.1	9	.. 572	+0 59.00	— 4 53.44	1 10 21.53	4 13 29.23
31	8 26 27.0	5	B. A. C. 448	—2 29.23	— 7 34.70	1 20 16.19	5 17 6.34
1858 Jan. 1	7 53 32.9	10	.. 448	—1 12.23	+ 0 36.40	1 24 33.19	5 25 17.16
6	7 53 42.2	13	Rümker N. F. 755	+1 1.14	+ 6 12.26	1 28 20.82	+ 6 8 23.65

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α			Authority	δ	Authority
		h	m	s			
Rümker N. F. 340	8	0	43	52.67	Rümker's Catalogue.	+ 1 59 1.46	Rümker's Catalogue.
Weisse O. 678	9	0	39	31.79	Y. 2.	1 35 30.58	Y. 2.
* 4	9.5	0	44	16.62	Washington Equatorial.	1 37 45.46	Washington Equatorial.
* 5	9.5	0	48	18.03	Y. 2.	1 32 12.45	Y. 2.
* 7	9	0	50	47.21	Y. 1.	1 43 44.80	Y. 1.
Weisse O. 902	9	0	52	12.48	Weisse's Catalogue.	2 19 39.61	Y. 1.
.. 912	9	0	52	41.14	..	2 32 49.89	Y. 2.
.. 979	8	0	56	13.20	..	2 30 11.26	Y. 2.
.. 1048	9	0	59	39.46	..	3 3 42.47	Y. 3.
Rümker N. F. 538	8.5	1	4	13.75	Rümker's Catalogue.	3 41 1.97	Y. 2.
.. 559	8	1	7	30.06	..	3 51 16.04	Y. 3.
.. 572	8	1	9	28.33	..	4 18 56.79	Rümker's Catalogue.
B. A. C. 448	5.5	1	22	51.05	B. A. Catalogue.	5 25 15.88	Y. 2.
Rümker N. F. 755	8.5	1	27	25.58	Rümker's Catalogue.	+ 6 2 38.77	Y. 2.

CIRCE.

Date	M. T. Washington.	No. Comp.	Comparison-Star.	③ - *		③'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1857 Oct. 13	^h 9 ^m 13 ^s 8.8	10	Weisse II. 38	-0 27.20	+ 9 41.69	^h 2 ^m 3 ^s 47.99	+ 9 4 14.02
17	9 55 34.8	3	Weisse I. 1038	+1 50.95	- 7 9.76	2 0 31.03	8 38 30.65
20	8 55 22.2	10	" 1080	-2 43.52	+ 8 54.94	1 58 5.18	8 19 29.87
"	"	10	" 1071	-2 1.70	+ 9 21.81	1 58 5.51	8 19 32.35
21	8 55 25.4	10	" 978	+2 9.58	-10 44.18	1 57 14.86	+ 8 13 7.28

Adopted Mean Places for 1860.0 of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
Weisse II. 38	9	^h 2 ^m 4 ^s 21.05	Weisse's Catalogue.	+ 8 54 58.39	Y. 1. M. 1.
" I. 1038	9	1 58 45.87		8 46 6.78	Y. 1.
" 1080	7	2 0 54.44		8 11 0.96	Y. 2.
" 1071	8	2 0 12.95		8 10 36.76	Y. 2.
" 978	7	1 55 11.01	Rümker, Catal. N. F.	+ 8 24 18.15	Rümker 2.— Y. 2.

IRENE.

Date.	M. T. Washington	No. Comp.	Comparison-Star.	④ - *		④'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1857 Nov. 14	^h 9 ^m 43 ^s 29.3	5	Weisse III. 295	-1 4.25	+ 0 28.40	^h 3 ^m 16 ^s 13.81	+ 9 30 58.80
25	9 25 3.1	7	" 26	+2 24.97	- 7 43.62	3 5 31.63	9 20 13.08
26	8 24 59.4	12	" 26	+1 32.31	- 8 5.63	3 4 41.95	9 19 51.07
27	8 6 19.3	20	" 26	+0 38.68	- 8 24.68	3 3 48.29	9 19 32.02
28	7 44 56.0	16	" 26	-0 13.82	- 8 36.62	3 2 55.76	+ 9 19 20.09

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
Weisse III. 295	9	^h 3 ^m 17 ^s 23.67	Weisse's Catalogue.	+ 9 30 45.27	Y. 1.
" 26	8	3 3 15.18	Rümker & Santini.	+ 9 28 15.11	Rümker, Santini, Y. 1.

FORTY-SEVENTH ASTEROID.

Date.	Washington M. T.	No. Comp.	Comparison-Star.	⑦ - *		⑦'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1857 Nov. 7	^h 8 ^m 28 ^s 38.4	4	Weisse XXIII. 678	+0 21.26	+ 4 12.44	^h 23 ^m 33 ^s 38.06	- 2 5 35.36

Adopted Mean Place of Weisse XXIII. 678.

α	Authority.	δ	Authority.
23 ^h 33 ^m 19 ^s .68	Weisse's Catalogue.	- 2° 9' 9".16	Y. 2.

The α and δ marked Y. and M. are from observations with the Mural by Professors YARNALL and MAJOR.

ELEMENTS OF THE FIRST COMET OF 1858.

BY JAMES C. WATSON.

THE elements have been computed from the following observations :

1858	Ann-Arbor M. T.	α	δ	Comp.
Jan. 19	11 ^h 17 ^m 44 ^s .3	0 ^h 49 ^m 23 ^s .37	+24° 39' 32.2	6
20	8 53 17.9	0 53 10.22	23 41 49.0	10
21	7 30 17.1	0 57 6.19	+22 40 52.9	12

They are :

ELEMENTS OF COMET 1858 I.

$T =$	1858 Feb. 20.185458	Washington M. T.
$\pi =$	113° 42' 24.9	} Mean Equinox 1858.0
$\Omega =$	269 19 12.8	
$i =$	52 53 45.9	
$\log q =$	0.011962	
<i>Motion Direct.</i>		

The middle place is represented in the following manner :

$$C. - O. \\ \Delta\alpha = -3'.2; \quad \Delta\beta = +0''.3$$

These elements very much resemble those of the Second Comet of 1790, discovered by MÉCHAIN, at Paris, on January 9 of that year, and for which he has given the following elements :

$T =$	1790 Jan. 28.3233	Paris M. T.
$\pi =$	111° 44' 37''	
$\Omega =$	267 8 37	
$i =$	56 58 13	
$\log q =$	0.026650	

Motion Direct.

Ann-Arbor, 1858 Jan. 23.

JAMES C. WATSON.

LETTER FROM PROFESSOR BRÜNNOW TO THE EDITOR.

Ann-Arbor, 1858 January 27.

MR. TUTTLE'S Comet was observed here on three evenings, as follows :

Ann-Arbor M. T.	α	δ	Comp. - Star.
1858 Jan. 19	0 49 23.37	+24 39 32.2	(a)
20	0 52 50.42	23 47 9.0	(b)
20	0 53 10.22	23 41 49.0	(b)
21	0 57 6.19	+22 40 52.9	(c)

Adopted Mean Places of Comparison-Stars.

*	Mag.	α	δ	Authority.
(a)	8.9	0 51 0.39	+24 38 46.5	Equat. from Bessel's Zones 445, 37
	9	0 52 45.63	24 41 10.9	Bessel's Zones 445, 37
(b)	7.8	0 50 51.17	23 45 15.0	" " 445, 33
(c)	9	0 58 45.87	22 41 14.1	Equat. from Bessel's Zones 392, 73
	8.9	1 3 4.05	+22 42 32.6	Bessel's Zones 392, 73

The first observation was made by Mr. WATSON, with the ring-micrometer; the two others were made by Mr. WATSON and myself, with the filar micrometer of our large telescope of 12" aperture. On account of the moonlight, the comet appeared very faint, and the comparisons show greater discrepancies than usual.

I send you also a few observations of asteroids, which I have made with the Meridian-Circle.

METIS.

Ann-Arbor M. T.	(9) α	(9) δ	C.—O.	
	α	δ	α	δ
1857 Nov. 25	4 56 37.27	+22 56 46.6	— 0.95	— 1.3
26	4 55 33.54	22 59 0.2	0.74	1.6
28	4 53 23.93	23 3 18.9	0.84	0.8
Dec. 2	4 48 57.31	23 11 28.6	0.76	2.0
14	4 35 42.64	+23 31 48.3	— 0.85	— 1.8

FLORA.

Ann-Arbor M. T.				(8) α	(8) δ	C.—O.			
		^{h}	^{m}	^{s}	^{h}	^{m}	^{s}	α	δ
1858	Jan. 9	12	16	15.2	7 34	37.09		+21 47 6.0	+ 0.51 — 1.9
	19	11	26	5.7	7 23	11.39		22 49 28.5	0.51 1.4
	20	11	21	5.6	7 22	10.05		22 55 13.7	0.51 0.6
	21	11	16	6.8	7 21	7.04		23 0 53.7	0.39 1.1
	22	11	11	9.3	7 20	5.20		+23 6 26.6	+ 0.30 — 1.1

The error of the *Flora*-tables is therefore still very small, though six years have elapsed since the last opposition on which they are based.

The geographical position of Ann-Arbor is

Latitude $42^{\circ} 16' 48''$

Longitude $0^h 27^m 12^s$ W. from Washington.

F. BRUNNOW.

FIRST COMET OF 1858.

THIS Comet, detected by Mr. H. P. TUTTLE, Jan. 4, was independently found by Dr. BRUHNS in Berlin, Jan. 11. Two observations are given in the *Astr. Nachr.* of Jan. 20 :

		M. T. of Place.	α	δ
Berlin,	Jan. 11	$10^h 47^m 49^s.6$	$0^h 13^m 20^s.94$	$+33^{\circ} 15' 35''.9$
Altona,	13	9 17	0 22 2	31 17

By a curious coincidence, the elements deduced by Dr. BRUHNS, from these observations together with one made at Berlin Jan. 16, resemble those of Comet 1785 I. so closely that he considers the identity beyond doubt. And there is quite as little doubt that both the published and unpublished elements obtained by American computers bear a still closer resemblance to those of the Second Comet of 1790. The inclination of the orbit was 70° for the former and 57° for the latter comet.

Cambridge, 1858 Feb. 12.

G.

NOTICE.

THE Editor of this Journal will transfer his residence to the city of Albany, on or about February 18, and requests that all communications for him may be addressed to the Dudley Observatory in that city.

The observatory-building is now completed with the exception of a few details, and the magnificent "Olcott-Circle", recently constructed by Messrs. PISTOR and MARTINS in Berlin, will be mounted as soon as possible. Through the munificence of JOHN F. RATHBONE, Esq., the Dudley Observatory also possesses the Tabulating Engine made by the Messrs. SCHEUTZ; and the Director hopes before long to render this a source of valuable aid. A heliometer of large size is constructing by Mr. SPENCER of Canastota; but in the absence of any large equatorial telescope, it becomes necessary to abandon for the present the undertaking of the observation of four asteroids, conditionally assumed in N° 96 of this Journal.

By the use of the meridian-circle and the calculating engine, useful if not brilliant contributions may be made to astronomy; and with advancing financial prosperity, it is to be hoped that the Dudley Observatory may yet receive an outfit and endowment equal to the hopes of its most sanguine friends.

B. A. GOULD JR.

Cambridge, 1858 Jan. 26.

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LETTER FROM PROFESSOR BRUNNOW TO THE EDITOR.

FIRST COMET OF 1858.

NOTICE.

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ALBANY, 1858, MARCH 21.

NO. 15.

THE INFLUENCE OF THE EARTH'S ROTATION UPON ROTATING BODIES AT ITS SURFACE.

BY W. FERREL.

IN a late number of this Journal we endeavored to show that a moving body at the surface of the earth is subject to deflecting forces, depending upon the earth's rotation, which causes its motion relative to the earth to deviate a little from what it would be if the earth were at rest. It is proposed to show here, that the same deflecting forces operate upon the different parts of a rotating body at the earth's surface; so that if it be suspended so as to be free to turn about any axis passing through the center of gravity, the axis of revolution will not remain permanent, but change its direction in consequence of the action of these deflecting forces. This article is designed to be a supplement to the former, and consequently is based upon its fundamental equations.

If we put m , p and q for the sum of the moments of the forces which tend to turn the rotating body around the axes which are perpendicular respectively to the plane of the meridian, the prime vertical and the horizon, using the same notation as in the former article, and putting r' , θ' and ϖ' for the values of r , θ and ϖ belonging to the center of gravity, we shall have

$$\begin{aligned} m &= \int r(r-r') \frac{dd\theta}{dt^2} dm - \int r(\theta-\theta') \frac{ddr}{dt^2} dm, \\ p &= \int r(r-r') \sin \theta \frac{dd\pi}{dt^2} dm - \int r \sin \theta(\varpi-\varpi') \frac{ddr}{dt^2} dm, \quad [1] \\ q &= \int r^2 \sin \theta(\varpi-\varpi') \frac{dd\theta}{dt^2} dm - \int r^2 \sin \theta(\theta-\theta') \frac{dd\pi}{dt^2} dm. \end{aligned}$$

Let ρ = the distance of any particle dm of the rotating body from the axis of rotation;

α = The distance from the center of gravity of a plane passing through any particle dm , perpendicular to the axis of rotation;

ψ = the angle of elevation of the axis above the horizon;

φ = the angle between the plane of the meridian and a vertical plane passing through the axis, the angle being reckoned from the north toward the east;

μ = the angle between two planes passing through the axis, one of which is vertical, and the other passes through the particle dm .

We shall then have

$$\begin{aligned} r-r' &= -\alpha \sin \psi + \rho \cos \psi \cos \mu, \quad [2] \\ r(\theta-\theta') &= \alpha \cos \psi \cos \varphi + \rho \sin \varphi \sin \mu + \rho \sin \psi \cos \varphi \cos \mu, \\ r \sin \theta(\varpi-\varpi') &= -\alpha \cos \psi \sin \varphi + \rho \cos \varphi \sin \mu - \rho \sin \psi \sin \varphi \cos \mu. \end{aligned}$$

In obtaining the values of $\frac{dr}{dt}$, $\frac{d\theta}{dt}$ and $\frac{d\pi}{dt}$ from the preceding equations, $\frac{d\psi}{dt}$ and $\frac{d\varphi}{dt}$ may be neglected in the present investigation, since they are exceedingly small in comparison with $\frac{d\mu}{dt}$; and $\frac{d\mu}{dt}$ may also be put equal v , the rotatory velocity of the rotating body. Hence we obtain

$$\begin{aligned} \frac{dr}{dt} &= -\rho \cos \psi \sin \mu v, \\ r \frac{d\theta}{dt} &= \rho \sin \varphi \cos \mu v - \rho \sin \psi \cos \varphi \sin \mu v, \quad [3] \\ r \sin \theta \frac{d\pi}{dt} &= \rho \cos \varphi \cos \mu v + \rho \sin \psi \sin \varphi \sin \mu v. \end{aligned}$$

By means of equations [2] and [3], together with equations [5] of the former article, neglecting all terms which are 0 by integration, equations [1] may be reduced to the following forms:

$$\begin{aligned} m &= -2 n v (\sin \theta \sin \psi - \cos \theta \cos \psi) A, \\ p &= -2 n v \cos \theta \cos \psi \sin \varphi A, \quad [4] \\ q &= -2 n v \sin \theta \cos \psi \sin \varphi A, \end{aligned}$$

in which $A = \int \rho^2 \sin^2 \mu dm$.

If in these equations we put $\varphi = 0$ and $\psi =$ the complement of θ , that is, if we suppose the axis of the rotating body to be parallel with the axis of the earth, we shall have $m = 0$, $p = 0$ and $q = 0$; and hence the axis of the rotating body is in this case permanent. In all other positions the deflecting forces will cause it to change its direction, and its motion may be determined by the preceding equations. If the axis of the rotating body is free to move in the plane of the meridian only, its motion may be determined by the first of equations [4], and is oscillatory about the position in

which it is parallel to the axis of the earth. If it is free to move in the prime vertical only, its motion is determined by the second of equations [4], which is the equation of the pendulum, and the oscillations are about the perpendicular position of the axis. Lastly, if it is free to move horizontally only, its motion is determined by the last of equations [4], which is likewise the equation of the pendulum, and the oscillations are about its position when in the plane of the meridian. These deflecting forces, however, are so small, and, in any experiments with the most delicate apparatus, the friction in comparison is so great, that these oscillations are not observed, but only a tendency of the axis of rotation to assume the position in which all the forces are in equilibrium, which, in the general case in which the axis of rotation is free to turn in any direction, is a position parallel with the axis of the earth.

These deductions from theory are completely verified by some very delicate experiments which have been made by FOUCAULT with a peculiar form of the gyroscope, an account

of which has been given by M. J. NICKLES in the *American Journal of Science and Arts*, Vol. XV, p. 263. See also Vol. XIX, p. 141. It is, however, stated by M. NICKLES, that the angular movement about the vertical axis may be shown to be proportional to the sine of the latitude; whereas, from the last of equations [4], it must be as the sine of the polar distance, and this is also evident from other considerations. It is well known that a descending body, on account of the earth's rotation, is deflected towards the east; and, on the contrary, an ascending body, towards the west. Hence when the torus of FOUCAULT's apparatus is placed in the plane of the meridian, the side which descends is deflected towards the east, and the side which ascends, towards the west; and hence there is a torsion of the torus when free to move about a vertical axis, and the force which produces it is well known to be as the sine of the polar distance. The last of equations [4] is an expression of this force, and there is no other which tends to turn the torus or rotating body around a vertical axis.

Nashville (Tennessee), Jan. 12, 1858.

ORBIT OF VIRGINIA.

BY JOHN N. STOCKWELL.

THE elements of *Virginia* given by Mr. FERGUSON (*Astr. Journal*, N^o 108), compared with the observations, give the following residuals:

Date.	C.—O.		
	μ	δ	
1857 Oct. 7.0	+ 2.75	— 2.58	8 observations.
Nov. 10.5	+ 3 0.72	+1 50.90	1 "
Dec. 12.5	+13 42.94	+7 29.64	4 "

Hence we get the following normal places:

1857	α	δ	
Oct. 7.0	13° 56' 18.55	+3° 40' 56.98	
Nov. 10.5	10 30 8.58	+1 15 55.60	
Dec. 12.5	14 41 27.12	+2 57 49.78	
			Mean Equinox 1857 Jan. 1.0

These normals give the following

ELEMENTS OF VIRGINIA.

1857 Oct. 7.0 Washington M. T.

M	=	2° 14' 31.27	} Mean Eq. 1857 Jan. 1.0
Ω	=	173 30 49.32	
π	=	10 6 56.87	
i	=	2 47 50.70	
q	=	16 39 55.33	
$\log a$	=	0.4229928	
$\log \mu$	=	2.9155174	

These elements represent the middle observation as follows:

C.—O.

$$\mu = -0.08; \delta = -0.03.$$

It is my intention to compute the perturbations, and thus furnish more accurate elements, and an ephemeris for the next opposition.

ELEMENTS OF THE FIRST COMET OF 1858.

BY T. H. SAFFORD.

From observations at Cambridge, Jan. 4 and Feb. 6; and at Altona, Jan. 21.

ω	=	206° 48' 58.8
q	=	55 6 31.2
Ω	=	269 3 25.5 M. Equinox 1858.0
i	=	54 24 17.2
$\log a$	=	0.756228

The period is 13.625 years, or nearly $\frac{1}{5}$ of the interval (68^y 26^d) since the last observed perihelion passage.

All the observations are satisfied within 1'.

EPHEMERIS OF EUNOMIA FOR THE OPPOSITION OF 1859,

AND CONTINUATION OF THE PERTURBATIONS GIVEN IN PREVIOUS REPORT.

BY ERNEST SCHUBERT.

[Communicated by Professor WINLOCK, Superintendent American Ephemeris.]

Mean Washington Midnight.

1859	(15) α			(15) δ	log Δ	log r	1859	(15) α			(15) δ	log Δ	log r			
	^h	^m	^s	[°]	[']	["]		^h	^m	^s	[°]	[']	["]			
April 6	15	19	45.99	—33	55	28.3	0.360181	0.492920	May 13	14	47	48.58	—32	28	40.6	0.322315
7	19	11.43		56	17.6	358377		14	16	50.92	23	6.0	322329	0.489352		
8	18	35.45		56	57.7	356605	492761	15	45	53.74	17	23.6	322371			
9	17	58.07		57	28.1	354865		16	44	57.08	11	33.6	322469	489134		
10	17	19.32		57	49.4	353159	492599	17	44	1.02	32	5	36.6	322623		
11	16	39.23		58	0.3	351488		18	43	5.59	31	59	32.8	322834	488911	
12	15	57.81		58	1.0	349852	492433	19	42	10.85	53	22.1	323101			
13	15	15.17		57	51.5	348253		20	41	16.85	47	5.9	323424	488685		
14	14	31.25		57	31.3	346693	492264	21	40	23.63	40	13.5	323804			
15	13	46.12		57	0.1	345173		22	39	31.25	34	15.7	324239	488457		
16	12	59.81		56	18.8	343693	492092	23	38	39.76	27	13.0	324729			
17	12	12.38		55	26.3	342255		24	37	49.21	21	5.6	325273	488224		
18	11	23.86		54	22.9	340859	491917	25	36	59.63	14	21.1	325870			
19	10	34.30		53	8.6	339506		26	36	11.07	7	38.8	326520	487989		
20	9	43.71		51	43.3	338197	491739	27	35	23.58	31	0	50.0	327222		
21	8	52.22		50	6.8	336933		28	34	37.20	30	53	58.3	327976	487750	
22	7	59.79		48	19.1	335715	491557	29	33	51.97	47	1.1	328780			
23	7	6.49		46	20.2	334515		30	33	7.93	40	7.7	329634	487509		
24	6	12.37		44	10.0	333424	491372	31	32	25.41	33	9.7	330537			
25	5	17.49		41	18.6	332353		June 1	31	43.56	26	10.4	331489	487264		
26	4	21.90		39	15.8	331332	491184	2	34	3.34	19	10.2	332489			
27	3	25.65		36	31.6	330362		3	30	24.38	12	9.5	333534	487017		
28	2	28.80		33	36.2	329445	490993	4	29	16.79	30	5	8.7	334625		
29	1	31.42		30	29.6	328582		5	29	10.56	29	58	8.4	335760	486765	
30	15	0	33.57	27	11.8	327772	490799	6	28	35.72	51	8.7	336936			
May 1	14	59	35.33	23	42.9	327015		7	28	2.28	44	10.0	338153	486511		
2	58	36.76		20	3.2	326314	490602	8	27	30.26	37	12.5	339411			
3	57	37.91		16	12.8	325669		9	26	59.68	30	16.8	340710	486254		
4	56	38.87		12	11.8	325080	490402	10	26	30.56	23	23.2	342047			
5	55	39.69		8	0.5	324517		11	26	2.91	16	31.9	343421	485994		
6	54	40.43	33	3	39.0	324071	490198	12	25	36.74	9	43.3	344831			
7	53	41.16	32	59	7.5	323651		13	25	12.06	29	2	57.7	346276	485731	
8	52	41.92		54	26.1	323288	489990	14	24	48.89	28	56	15.4	347755		
9	51	42.79		49	35.1	322984		15	24	27.24	19	36.9	349266	485465		
10	50	43.83		44	34.7	322738	489780	16	24	7.12	13	2.4	350809			
11	49	45.10		39	25.3	322549		17	14	23	48.53	—28	36	32.0	0.352383	0.485195
12	14	48	46.66	—32	34	7.2	0.322418	0.489567								

$\varnothing$ 1859 May 10. 13^h 54^m 46^s.6 Washington M. T. Intensity of light = 0.447. r is the undisturbed radius-vector in the ellipse 1854.0

CONTINUATION OF THE PERTURBATIONS OF EUNOMIA BY $\mathcal{U}$ AND $\mathcal{h}_2$.

Washington M. T.	$\mathcal{U}$	$\mathcal{h}_2$	$\mathcal{U}$	Washington M. T.	$\mathcal{U}$	$\mathcal{h}_2$	$\mathcal{U}$
1858 June 8	—10349.7	+53362.5	+27006.8	1859 Feb. 3	—32223.5	+48808.8	+25541.3
July 18	13915.8	55010.6	28134.6	Mar. 15	34527.9	44979.3	23712.9
Aug. 27	17826.9	55702.1	28670.4	Apr. 24	36018.8	40534.3	21694.2
Oct. 6	21834.1	55400.5	28632.1	June 3	36606.1	35625.8	19481.8
Nov. 15	25705.9	54114.0	28058.7	July 13	36238.2	30419.7	17191.5
Dec. 25	—29230.7	+51889.9	+27005.7	Aug. 22	—31903.0	+25089.5	+14904.2

EPIHEMERIS OF IRIS FOR THE OPPOSITION IN 1860,

WITH CONTINUATION OF THE PERTURBATIONS.

BY ERNEST SCHUBERT.

[Communicated by Professor WINLOCK, Superintendent American Ephemeris.]

Washington Mean Midnight.

1860	$\overline{\gamma}$ α	$\overline{\gamma}$ δ	$\log \Delta$	$\log r$	1860	$\overline{\gamma}$ α	$\overline{\gamma}$ δ	$\log \Delta$	$\log r$
	^h ^m ^s	[°] ['] ["]				^h ^m ^s	[°] ['] ["]		
Jan. 0	10 0 6.22	+ 5 21 55.3	0.174240	0.352460	Feb. 6	9 31 42.29	+ 5 58 51.5	0.137057	
1	9 59 48.63	22 26.3	172225		7	30 38.95	6 2 47.1	137491	0.371354
2	59 29.12	20 8.7	170245	353479	8	29 35.66	6 48.4	138011	
3	59 7.69	18 2.6	168300		9	28 32.48	10 55.1	138616	372315
4	58 44.36	16 8.0	166393	354496	10	27 29.47	15 6.8	139307	
5	58 19.12	14 25.2	164526		8 11	26 26.77	19 23.1	140084	373273
6	57 54.99	12 51.1	162701	355511	12	25 24.44	23 43.6	140947	
7	57 22.99	11 34.9	160919		13	24 22.57	28 7.9	141896	374226
8	56 52.15	10 27.6	159182	356524	14	23 21.24	32 35.7	142930	
9	56 19.47	9 32.3	157494		15	22 20.53	37 6.4	144048	375177
10	55 44.99	8 48.9	155856	357534	16	21 20.53	41 39.7	145248	
11	55 8.74	8 17.5	154268		17	20 21.29	46 15.1	146529	376123
12	54 30.74	7 58.0	152733	358542	18	19 22.88	50 52.2	147891	
13	53 51.02	7 50.4	151254		19	18 25.40	6 55 30.6	149331	377066
14	53 9.64	7 54.6	149831	359545	20	17 28.92	7 0 9.9	150850	
15	52 26.61	8 10.9	148468		21	16 33.49	4 49.7	152446	378003
16	51 11.97	8 39.0	147166	360547	22	15 39.20	9 29.5	154117	
17	50 55.76	9 18.8	145929		23	14 46.10	14 9.0	155861	378938
18	50 8.03	10 10.3	144758	361546	24	13 54.24	18 47.9	157677	
19	49 18.87	11 13.4	143654		25	13 3.68	23 25.6	159562	379867
20	48 28.30	12 27.8	142619	362541	26	12 14.45	28 2.0	161515	
21	47 36.41	13 53.5	141655		27	11 26.64	32 36.5	163534	380793
22	46 43.25	15 30.2	140764	363533	28	10 40.28	37 9.1	165617	
23	45 48.89	17 17.9	139948		29	9 55.42	41 39.2	167762	381714
24	44 53.37	19 16.2	139207	364523	Mar. 1	9 12.10	46 6.6	169968	
25	43 56.76	21 25.0	138545		2	8 30.39	50 31.0	172231	382632
26	42 59.16	23 43.9	137962	365508	3	7 50.29	54 52.3	174550	
27	42 0.63	26 12.7	137460		4	7 11.81	7 59 9.9	176923	383545
28	41 1.25	28 51.1	137010	366492	5	6 34.97	8 3 23.8	179346	
29	40 1.12	31 38.8	136703		6	5 59.81	7 33.6	181820	384453
30	39 0.30	34 35.0	136449	367471	7	5 26.35	11 39.4	184341	
31	37 58.89	37 39.9	136279		8	4 54.62	15 40.6	186908	385358
Feb. 1	36 56.94	40 53.2	136193	368447	9	4 24.62	19 37.4	189519	
2	35 54.56	44 14.5	136193		10	3 56.39	23 29.4	192172	386258
3	34 51.82	47 43.2	136278	369419	11	3 29.96	27 16.4	192863	
4	33 48.81	51 19.2	136450		12	9 3 5.37	+ 8 30 58.2	0.197594	0.387154
5	9 32 45.60	+ 5 55 2.1	0.136709	0.370388					

8 1860 February 10, 20^h 27^m 15^s.2 Washington M. T.

Intensity of light = 1.033.

PERTURBATIONS OF IRIS FROM 1848 JAN. 1.0, TO 1860 FEB. 9.0.

	di	$d\Omega$	dq	$d\pi$	$d\mu$	$fd\mu$	dM
$\mathcal{U}$	— 20.14	— 570.35	+ 31.49	— 430.87	— 0.34141	— 478.89	— 85.58
$\mathcal{h}$	+ 0.56	— 17.26	— 3.02	+ 33.53	— 0.01142	+ 30.46	— 54.23
$\mathcal{U} + \mathcal{h}$	— 19.58	— 9 47.61	+ 28.47	— 6 37.34	— 0.35283	— 7 28 43	— 2 19.84
Correct. for the sec. var. of obliquity	— 0.17	+ 1 2.19		— 0.29			

OSCULATING ELEMENTS OF *IRIS*.

1860 Feb. 9.0 Berlin M. T.

$$\begin{aligned}
 M &= 73^{\circ} 29' 13.0 \\
 \pi &= 41' 29'' 40.8 \\
 \Omega &= 259^{\circ} 47' 16.1 \\
 i &= 5^{\circ} 27' 57.4 \\
 q &= 13' 22'' 13.1 \\
 \mu &= 962''.5112 \\
 \log \mu &= 2.9834059 \\
 \log a &= 0.3777337
 \end{aligned}
 \left. \vphantom{\begin{aligned} M \\ \pi \\ \Omega \\ i \\ q \\ \mu \end{aligned}} \right\} \text{M. Eq. Epoch}$$

LETTER FROM MR. STILLMAN MASTERMAN TO THE EDITOR.

Weld (Maine), 1858 March 8.

ACCORDING to my observations, the absolute maximum of *Omicron Ceti* occurred 1857 Dec. 16, or sixteen days later than the time given by ARGELANDER's formula of sines. At its maximum it was a little inferior in brilliancy to α of the same constellation, but considerably brighter than β *Arietis*. If, with ARGELANDER, we indicate the brightness of the faintest star visible to the naked eye by 0, and that of *Aldebaran* by 50, the maximum of *Mira* was between 36 and 37. Its color was of a decidedly reddish hue. The mean maximum, obtained by taking the means of the times at which the star exhibited equal degrees of brightness before and after its maximum,—using for this purpose all the observations during the period that its brilliancy exceeded that of γ *Ceti*, and finally computing the mean of all these means,—occurred some days later than the true maximum, viz. 1857 Dec. 24.16. The star was invisible to the naked eye in a very clear sky, Oct. 17.5. Between this date and Nov. 7, the unfavorable state of the atmosphere rendered observations impossible; but on the last named day it was observed of the 5 magnitude. From this it increased quite rapidly for a few days, and then more slowly; reaching the third magnitude on the first of December. For the last two weeks of its increase, this was not very irregular. From the maximum, it fell rapidly at first; but from Dec. 21 to 1858 Jan. 3, the diminution was insensible. For several days after the last named date the decrease in brightness was very slow, but soon became more rapid; and from the first to the middle of February, the diminution amounted to a whole magnitude. Feb. 14, it was of the 4 magnitude. Towards the last of February, although above the 5 magnitude, it became very difficult to observe on account of twilight and nearness to the horizon. Calling the intensity of light in Sir JOHN HERSHEY's unit (α *Centauri*) of his photometrical scale, 1000, I found the maximum intensity of *Mira* to be 121.40. Annexed is a table of the photometrical magnitudes of *Mira*, according to HERSHEY's scale, for every second day while it equaled or exceeded γ *Ceti* in intensity, deduced from my observations with but few interpolations. My observations were made when the star was as near the meridian as circumstances would admit.

PHOTOMETRIC MAGNITUDES OF *OMICRON CETI*:(α *Centauri* = 1.00.)

Date.	Phot. Mag.	Date.	Phot. Mag.
1857 Nov. 23	3.71	1857 Dec. 29	3.01
25	3.61	Dec. 31	3.01
27	3.51	1858 Jan. 2	3.01
Nov. 29	3.46	4	3.04
Dec. 1	3.41	6	3.09
3	3.38	8	3.13
5	3.34	10	3.17
7	3.31	12	3.21
9	3.18	14	3.31
11	3.08	16	3.36
13	3.01	18	3.41
15	2.91	20	3.46
17	2.90	22	3.51
19	2.91	24	3.51
21	3.01	26	3.56
23	3.01	28	3.61
25	3.01	30	3.68
Dec. 27	3.01	Feb. 1	3.71

March 6.30. *Mira* was barely visible to the naked eye in a clear sky, having been above the 7 magnitude more than four months.

I also annex a table of the minima of *T Cancri*, visible at Washington during 1858 and 1859; which have been obtained from the following elements, the light-equation having been applied:

Fundamental Epoch: 1854 June 22, 5^h 53^m 42^s Washington M. T.
 Period 9^d 11^h 36^m 55^s.

MINIMA OF *T CANCRI*,

visible at Washington in 1858 and 1859.

	^h	^m		^h	^m
1858 Jan. 11	13	3	1858 Nov. 1	13	15
30	12	17	20	12	26
Feb. 18	11	31	Dec. 9	11	38
Mar. 9	10	47	28	10	50
28	10	3	1859 Jan. 16	10	3
Apr. 16	9	19	Feb. 4	9	17
May 5	8	36	23	8	32
Sep. 5	15	41	Mar. 14	7	47
21	14	53	Dec. 14	8	37
Oct. 13	14	4			

ELEMENTS OF VIRGINIA.

BY JAMES FERGUSON.

THE following elements are computed from Washington observations of Oct. 5, Nov. 11 and Dec. 18.

$$\begin{aligned}
 M &= 1^{\circ} 35' 8.9 && \text{Oct. 5.0 1857} \\
 \Omega &= 173^{\circ} 29' 44.6 \\
 \pi &= 10^{\circ} 29' 20.8 \\
 i &= 2^{\circ} 17' 45.7 \\
 q &= 16.41 14.6 \\
 \log a &= 0.423109 \\
 \log \mu &= 2.914894
 \end{aligned}$$

NEW ASTEROIDS.

THE *fifty-first* of the asteroid-group was discovered by Mr. LAURENT at the observatory of Professor VALZ in Nismes. At the time of discovery it was of the 11 magnitude, but promised to attain the 10 magnitude at least, not having arrived at its stationary point. Mr. VALZ has given to it the name *Nemausa*, derived from that of the tutelary deity of the place.

The approximate positions given are :

Nismes M. T.		α	δ
1858 Jan. 22	14 ^h	11 ^h 55 ^m 41 ^s	— 1° 13.5
24	16	11 56 21	— 1 16.5

The *fifty-second* was detected, February 4, by Mr. GOLD-SCHMIDT, at Paris, and the following approximate positions found by him :

M. T. of Place.		α	δ
1858 Feb. 4	10 ^h 55 ^m	10 ^h 47 ^m 5 ^s	+ 12° 2
6	8 55	10 45 44	+ 12 16

Professor PETERS publishes an Altona observation :

1858 Feb. 9	13 ^h 24 ^m 30 ^s .2	10 ^h 43 ^m 45 ^s .9	+ 12° 35' 28.0 :
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and Professor LITTROW one at Vienna :

1858 Feb. 13	9 ^h 15 ^m 19 ^s .2	10 ^h 41 ^m 10 ^s .4	+ 13° 2' 5.2.
			G.

EPHEMERIS OF VESTA FOR 1858.

BY PROFESSOR AUGUSTUS W. SMITH.

[Communicated by Prof. WINLOCK, Superintendent American Ephemeris.]

Washington Mean Noon

1858	4	α	4	δ	$\log \Delta$	$\log r$	Mer. Pass.	1858	4	α	4	δ	$\log \Delta$	$\log r$	Mer. Pass.
		^h ^m		[°] ["]			^h ^m			^h ^m		[°] ["]			^h ^m
Jan. 0	13	35.5	— 2	35.9	0.35959	0.35797	18 59.5	July 9	11	0.2	— 5	16.3	0.22762	0.33300	6 52.2
10	13	49.5	3	26.7	33410	35614	18 33.9	19	14	9.2	6	52.8	25436	33257	6 21.7
20	14	2.5	4	5.8	30692	35433	18 7.2	29	14	20.2	8	33.6	28002	33226	5 53.2
30	14	14.1	4	32.0	27813	35256	17 39.1	Aug. 8	14	32.8	10	16.4	30442	33206	5 26.3
Feb. 9	11	23.8	4	44.4	24806	35082	17 9.1	18	14	46.9	11	59.2	32741	33198	5 1.0
19	14	31.5	4	42.2	21712	34913	16 36.1	28	15	2.4	13	40.3	34892	33200	4 37.0
Mar. 1	11	36.7	4	25.7	18612	34748	16 2.6	Sept. 7	15	19.1	15	17.8	36901	33217	4 14.1
11	14	39.1	3	55.3	15601	34590	15 25.3	17	15	36.8	16	50.3	38761	33244	3 52.4
21	14	38.5	3	12.7	12830	34437	14 45.0	27	15	56.6	18	16.1	40478	33283	3 32.7
31	14	34.5	2	22.2	10488	34291	14 1.3	Oct. 7	16	15.3	19	33.9	42057	33332	3 11.9
Apr. 10	14	27.8	1	29.4	08765	34151	13 15.0	17	16	35.8	20	42.5	43492	33393	2 52.8
20	14	19.1	0	19.9	07808	34020	12 24.8	27	16	57.0	21	40.6	44794	33465	2 34.6
30	14	9.7	— 0	7.6	07736	33896	11 37.8	Nov. 6	17	18.8	22	27.3	45957	33547	2 16.7
May 10	14	0.9	+	7.5	08519	33781	10 49.5	16	17	41.2	23	1.7	46987	33639	1 59.8
20	13	53.8	+	0.04	10037	33676	10 3.0	26	18	3.9	23	23.3	47884	33741	1 12.9
30	13	49.3	—	29.9	12136	33580	9 19.1	Dec. 6	18	26.8	23	31.9	48649	33852	1 26.4
June 9	13	47.7	1	19.9	11596	33493	8 38.1	16	18	49.8	23	27.3	49281	33972	1 9.9
19	13	49.2	2	26.7	17269	33448	8 0.4	26	19	12.8	23	9.8	49782	34101	53.4
29	13	53.4	— 3	46.7	0.20019	0.33351	7 24.9	36	19	35.7	— 22	39.9	0.50152	0.34237	36.8

EPIHEMERIS FOR OPPOSITION.

Washington Mean Noon.

1858	4	α	4	δ	$\log \Delta$	$\log r$	1858	4	α	4	δ	$\log \Delta$	$\log r$
Mar. 21	11	^h 38 ^m 21.72 ^s	—3	12 46.5	0.1283383	0.3443684	Apr. 23	11	^h 16 ^m 19.13 ^s	—0	29 51.6	0.0769356	0.3398195
22	38	6.64	3	7 58.5	1257712	3112191	21	15	22.75	26	12.8	0767318	3396949
23	37	49.66	3	3 6.8	1222181	3440704	25	11	25.93	22	10.8	0766167	3395711
24	37	30.83	2	58 11.6	1207716	3439225	26	13	29.10	19	19.4	0765906	3394481
25	37	10.16	2	53 13.4	1183429	3437752	27	12	32.27	16	7.8	0766524	3393260
26	36	47.69	2	48 12.3	1159611	3436286	28	11	35.55	13	6.6	0768016	3392047
27	36	23.33	2	43 6.3	1136478	3434826	29	10	39.02	10	16.2	0770382	3390843
28	35	57.20	2	37 57.3	1113645	3433373	30	9	42.75	7	37.0	0773615	3389648
29	35	29.30	2	32 45.8	1091465	3431928	May 1	8	46.83	5	8.4	0777707	3388461
30	34	59.67	2	27 31.0	1069859	3430488	2	7	51.35	2	52.5	0782667	3387283
31	34	28.33	2	22 16.4	1048846	3429057	3	6	56.37	—0	0 49.4	0788168	3386115
April 1	33	55.29	2	17 0.3	1028442	3427632	4	6	1.95	+0	1 1.0	0795108	3384954
2	33	20.58	2	11 41.7	1008668	3426214	5	5	8.21	2	38.4	0802527	3383803
3	32	44.22	2	6 22.6	0989545	3424804	6	4	15.22	1	3.0	0810848	3382662
4	32	6.28	2	1 3.0	0971091	3423401	7	3	23.03	5	14.5	0819943	3381528
5	31	26.77	1	55 43.6	0953322	3422005	8	2	31.68	6	12.9	0829838	3380402
6	30	45.77	1	50 24.6	0936264	3420616	9	1	41.30	6	58.0	0840509	3379286
7	30	3.32	1	45 7.0	0919934	3419235	10	0	51.93	7	29.5	0854962	3378180
8	29	19.47	1	39 51.1	0904350	3417862	11	14	0 3.61	7	17.1	0864154	3377082
9	28	31.27	1	34 37.1	0889529	3416496	12	13	59 16.50	7	50.9	0877087	3375994
10	27	47.80	1	29 26.5	0875489	3415138	13	58	30.56	7	41.1	0890725	3374915
11	27	0.25	1	24 19.1	0862252	3413787	14	57	45.91	7	17.6	0905067	3373846
12	26	11.33	1	19 15.3	0849823	3412444	15	57	2.56	6	40.5	0920087	3372786
13	25	21.41	1	14 15.4	0838214	3411108	16	56	20.59	5	49.0	0935771	3371734
14	24	30.48	1	9 20.2	0827437	3409781	17	55	10.01	1	42.6	0952096	3370692
15	23	38.62	1	4 30.1	0817506	3408462	18	55	0.99	3	24.2	0969038	3369660
16	22	15.90	0	59 15.7	0808119	3407150	19	54	23.45	1	51.0	0986577	3368638
17	21	52.37	0	55 7.6	0800201	3405816	20	53	17.49	+0	0 3.5	1008650	3367626
18	20	58.13	0	50 36.0	0792856	3404551	21	53	13.10	—0	0 58.3	1023374	3366623
19	20	3.30	0	46 11.6	0786388	3403261	22	52	10.31	4	11.5	1042598	3365630
20	19	7.93	0	41 54.9	0780801	3401981	23	52	9.16	6	39.3	1062342	3364646
21	18	12.10	0	37 45.9	0776098	3400713	24	51	39.68	9	19.9	1082582	3363671
22	14	17 15.90	—0	33 45.8	0.0772282	0.3399450	25	13	51 11.86	—0	12 13.7	0.1103299	0.3362706

ELLIPTIC ELEMENTS OF THE FIRST COMET OF 1858.

BY JAMES C. WATSON.

My first approximate elements of this comet (*Astron. Journal*, N° 110) were computed from observations of only three days, and, from the faintness and diffused appearance of the comet at the time when the observations were taken, were liable to considerable inaccuracy. I have therefore computed, from the observations at Cambridge (Mass.), Jan. 4, and Ann-Arbor, Jan. 19, and the following position :

1858 Ann-Arbor M.T. $\angle \alpha$ $\angle \delta$
 Feb. 3 $7^h 23^m 34^s.0$ $1^h 47^m 56^s.27$ $+8^\circ 51' 19''.1$,
 a new system of parabolic elements. They are the following :

$$\begin{aligned}
 T &= 1858 \text{ Feb. } 19.931471 \text{ Washington M. T.} \\
 \pi &= 109^\circ 2' 17.9 \\
 \Omega &= 266^\circ 25' 32.4 \\
 i &= 56^\circ 52' 17.4 \\
 \log q &= 0.026758
 \end{aligned}
 \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} \text{Mean Equinox 1858.0}$$

Motion Direct.

The middle place is represented in the following manner :

c.—o.

$$\Delta = -2' 45''.4 ; \quad \beta = -0' 49''.0.$$

The resemblance between these elements and those of the Second Comet of 1790 is so striking, that the identity of the comet may be considered as being beyond a doubt, while the large residual error in the middle place is alone sufficient to induce us to abandon the hypothesis of the parabolic form of the orbit ; and, in order to determine whether this is the first reappearance since 1790, or whether the comet has returned several times unperceived during this interval of 68 years, I have computed, by the ordinary method, with indeterminate eccentricity, the following system of elliptic elements :

Epoch =	1858 Jan. 30.5	Washington M. T.
M =	358° 19' 22.23	
π =	115° 46' 34.9	} Mean Equinox 1858.0
Ω =	269° 1' 30.9	
i =	54° 25' 49.1	
q =	55° 23' 41.4	
c =	0.823086	
$\log a$ =	0.763343	
$\log \mu$ =	2.404992	
μ =	254.0924	

Motion Direct.

These elements have been computed from the observations at Cambridge (Mass.), Jan. 4, and the two following positions:

1858 Ann-Arbor M. T.	ϕ α	ϕ δ
Jan. 30 7 ^h 12 ^m 20.6	1 ^h 32 ^m 57.69	+13° 2' 0.1
Feb. 24 7 52 52.7	2 57 7.87	-10 1 36.0,

and, compared with the middle place, exhibit the following residual error :

$$C. - 0. \\ \Delta \alpha \cos \delta = -2''.4; \quad \Delta \delta = -2''.1.$$

The period of revolution corresponding to the value of $\log a$ given in the above system of elliptic elements is 5101 days, or 13.965 years; and it is evident, therefore, that the comet has made five entire revolutions between 1790 and 1858. It must, moreover, have returned unperceived successively in the years 1803, 1817, 1831 and 1844, and may be expected to return again in 1871; and we may reasonably expect that the next and succeeding returns will be predicted with considerable precision.

Ann-Arbor, 1858 March 5.

ELEMENTS AND EPHEMERIS OF THE FIRST COMET OF 1858,

COMPUTED BY MR. A. HALL,

STUDENT IN ASTRONOMY AT THE OBSERVATORY OF HARVARD COLLEGE.

[Communicated by W. C. BOND, Esq.]

THE following elements have been deduced from the Cambridge observations of January 4, 8 and 12, and corrected by comparing with the observation of February 6. From these elements the ephemeris is computed.

T =	1858 Feb. 20.20167	Greenwich M. S. T.
π =	109° 14' 23	} App. Eq. Jan. 8
Ω =	266° 30' 34	
i =	56° 46' 19	
$\log q$ =	0.026058	

Direct.

If the brightness of the comet, seen from the Earth on the 4th of January, be put equal to unity, its brightness on March 1 will be 1.06, and, on March 20, 0.71.

Ephemeris for Greenwich Mean Midnight.

1858	ϕ α	ϕ δ	$\log \Delta$	$\log r$
March 1	3 ^h 12 ^m 38 ^s	-13° 19.3	0.0072	0.0306
2	15 33	13 59.1		
3	18 29	14 39.0	0.0140	0.0328
4	21 23	15 17.3		
5	24 17	15 55.6	0.0207	0.0352
6	27 9	16 32.5		
7	30 1	17 9.4	0.0273	0.0382
8	32 52	17 44.9		
9	35 43	18 20.4	0.0337	0.0415
10	38 33	18 54.6		
11	41 23	19 28.8	0.0401	0.0450
12	44 13	20 1.5		
13	47 3	20 34.6	0.0464	0.0489
14	49 52	21 6.3		
15	52 42	21 38.1	0.0525	0.0531
16	55 31	22 8.6		
17	58 20	22 39.3	0.0586	0.0576
18	4 1 9	23 8.7		
19	3 59	23 38.2	0.0644	0.0623
20	4 6 48	-24 7.0		

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NO. 16.

ON A METHOD IN DYNAMICS.

BY SIMON NEWCOMB.

It is proposed to investigate a method of determining the motion of a body which may be regarded as a free material point, having expressions for the forces which act upon it.

We know that all the forces which act on any body at the same instant may be compounded into two; and in the case which we consider, they may be compounded into a single one. It is evident that if we suppose all the forces to be thus compounded at each instant, the body will move under the influence of their resultant exactly as it would under the influence of the original forces, so that we may substitute the former for the latter. The problem will then be transformed into the following: Knowing the law of action of a single force on a material point, to determine the law of motion of the point.

If we obtain the general expression for the intensity and direction of this single force, which will hereafter be designated simply as the resultant, and thence deduce the differential equations of the motion of the point, it is evident that they will not differ from those that would have been obtained directly from the consideration of the original forces, and that therefore the rigorous integration will not be in any degree facilitated. Nevertheless the employment of the resultant will enable us to determine the motion of the body by successive approximations. If we determine the integrals of the motion of the point on the hypothesis that the intensity

and direction of the resultant changed in value according to some law different from the actual law of change, we may, by suitably varying the arbitrary constants in those integrals, determine the motion under the actual law of force. These arbitrary constants, when invariable, we shall suppose at each instant to appertain to that orbit in which the body would move, if the force, starting from its value at the instant, were to vary according to some simple law assumed at pleasure, the body being supposed to start with its velocity at the instant. Let us examine the analytical theory of this method. After we have assumed our law of force, it is evident that the assumed orbit of the body will be completely determined from knowing its position and velocity, and the intensity and direction of the resultant at the instant. If, then, we represent by the symbol q some quantity or quantities depending on this intensity and direction, the integrals of the motion will be of the form

$$a = f(x, y, z, D_t x, D_t y, D_t z, t, q); \quad [1]$$

a being an arbitrary parameter, invariable when q varies according to the assumed law. If therefore we represent by D_t the derivatives with respect to the time of the various quantities in the second member of the above equation on this hypothesis, and if we put for brevity

$$D_t x = x', \quad D_t y = y', \quad D_t z = z',$$

we shall have

$$0 = (D_t a) + D_x a D_t x + D_y a D_t y + D_z a D_t z + D_{x'} a D_t x' + D_{y'} a D_t y' + D_{z'} a D_t z' + D_\phi a D_t q. \quad [2]$$

We shall now determine the variation of a , on the supposition that the integral preserves the same form in the actual motion. If we represent the *actual* derivatives with respect to the time of the quantities x, y, z, x', y', z' , by the symbol

D , and represent by the characteristic δ the change in the derivative of q produced by the passage from the assumed to the true law of its variation, so that $D_t q = D_t q + \delta q$, we shall have for the derivative of the arbitrary parameter a ,

$$D_t a = (D a) + D_x a D_t x + D_y a D_t y + D_z a D_t z + D_{x'} a D_t x' + D_{y'} a D_t y' + D_{z'} a D_t z' + D_\phi a (D_t q + \delta q). \quad [3]$$

This expression may easily be simplified. Representing for a moment by X , Y , Z the components of the resultant in the direction of the axes of x , y , z respectively, we shall have

$$D_t x = X, \quad D_t y = Y, \quad D_t z = Z,$$

in whatever manner we suppose X , Y and Z to vary; and since we suppose the quantities to have the same values in the real and the assumed orbit, we have

$$D_t x' = D_t x, \quad D_t y' = D_t y, \quad D_t z' = D_t z. \quad [4]$$

Moreover the values of all the quantities which enter into the integral [1] being supposed the same in the two orbits at the instant, we have

$$D_t a = D_t a', \text{ etc.}$$

Wherefore, subtracting [2] from [3], we have

$$D_t a = D_\phi a \delta q; \quad [5]$$

so that the only change in a will be that produced directly by the change in q .

It is easily shown that the equations thus obtained suffice completely to determine the motion of the body. For, the resultant being given in terms of the time, or of quantities which depend on the time, the integration of the six equations of the form [5] will determine the values of the six arbitrary parameters. From the six equations [1] we can obtain the values of the coordinates of the body in terms of the arbitrary constants a , a' , etc., q , and the time; and then by substituting the values of the two former quantities in terms of the latter, we shall have the position of the body completely determined in terms of the time.

A property of the orbit assumed in the above manner is that it will, at each instant, have contact of the second order with the actual trajectory of the body. This theorem follows immediately from the equations [4], by giving them the form

$$D_t^2 x = D_t^2 x', \quad D_t^2 y = D_t^2 y', \quad D_t^2 z = D_t^2 z';$$

$$D_t a = D_x a (D_t x' - D_t x) + D_y a (D_t y' - D_t y) + D_z a (D_t z' - D_t z);$$

which is equivalent to the equation given by LAPLACE for the variations of the elements of the planets.

We shall now give some examples of integrals taken on various assumptions, which may serve to elucidate the above theory.

If the resultant force tends nearly to a fixed center, and its value differs little from a given function of its distance from that centre, we may regard it as being produced by a moving centre of attraction, whose intensity of action at various distances is exactly represented by this function. Its position would be determined by the condition that its force of attraction on the moving point must be equal to the resultant force. Two systems of integrals now present themselves prominently.

observing that the positions and velocity of the body are the same in the two orbits. It may also be deduced from the following considerations. It is evident that the resultant will at each instant be found in the plane osculatory to the actual trajectory of the body; and calling the resultant, which must vary in such a manner as to render the arbitrary parameters constant, the assumed resultant; if we consider the real resultant at the instant before, and also at the instant after any epoch, it will, in general, at one of the instants be less, and at the other greater than would suffice to keep the body in its assumed orbit at the epoch, since by hypothesis it has at the epoch the same value as the assumed resultant, but varies in a different manner. The projections of the two orbits on their common osculatory plane will therefore intersect each other at the point of osculation, and consequently have contact of an even order. At an infinitely small space of time from the epoch, the real resultant will differ from the assumed one by a quantity infinitely small of the first order, and will therefore draw the body out of the assumed orbit only by a quantity infinitely small of the third order; from which our proposition follows immediately.

If we apply the common method of the variation of arbitrary constants to the case which we now consider, viz. a material point moving under the action of a single force; the integrals would be taken on the supposition that while the point preserved its position and velocity, the force changed its value to another entirely independent of its value at the instant. The motion in the assumed orbit would then be entirely independent of this last value, and therefore the integrals would no longer contain the functions q . Since the force acting on the body in the real orbit is different from that in the assumed orbit, the equations [4] would no longer be true; and since the derivatives of x , y , z , and t have the same value in both orbits, we should have for the derivative of the arbitrary parameter in the real orbit,

I°. A system taken on the assumption that the center of force is reduced to a state of rest, and caused to remain in that state. The motion of the body in the assumed orbit will then depend only on its position relatively to the center of force, and on its velocity, so that each integral will be of the form

$$a = f(x - \xi, y - \eta, z - \zeta, D_t x, D_t y, D_t z, t). \quad [6]$$

ξ , η and ζ here represent the coordinates x , y and z respectively of the assumed attractive center, and are the quantities which correspond to the function q in equation [1]. Since then we have by assumption

$$D_t \xi = 0, \quad D_t \eta = 0, \quad D_t \zeta = 0.$$

the general expression [5] for the derivative a in the real state of the motion becomes, by observing that $D_{\xi}a = -D_{\xi}a$,

$$D_{\xi}a = -D_{\xi}a D_{\xi}\xi - D_{\eta}a D_{\eta}\xi - D_{\zeta}a D_{\zeta}\xi; \quad [7]$$

an equation which might have been deduced directly by a process of reasoning exactly similar to that employed in deducing [5].

2°. We might take the integrals on the assumption that the center of force (supposed possessed of the property of inertia) and the moving body were left to their mutual attraction, each starting with the velocity which it has at the instant. The integrals would then be of the form

$$a = f(x - \xi, y - \eta, z - \zeta, x' - \xi', y' - \eta', z' - \zeta', t). \quad [8]$$

In this case we have by hypothesis

$$D_{\xi}\xi = D_{\xi}\xi, \quad D_{\eta}\eta = D_{\eta}\eta, \quad D_{\zeta}\zeta = D_{\zeta}\zeta,$$

and $D(\xi', \eta', \text{ or } \zeta') =$ the acceleration which would be produced in the motion of the hypothetical moving center by the attraction of the moving body. We should have, then, by giving to δ the same signification as in [5],

$$D_{\xi}a = -D_{\xi}a \delta\xi - D_{\eta}a \delta\eta - D_{\zeta}a \delta\zeta. \quad [9]$$

It may be interesting to notice the forms which the general equations may take in the case of a projectile acted on by equal and parallel forces, and moving in a resisting medium. It seems then most natural to take our integrals on the supposition that the resultant is invariable both in intensity and direction; or, in other words, to suppose the projectile at each instant to be moving in that parabola in which it would move if the resultant of both the forces which act on it kept the value which it has at the instant. Since the projectile will remain in the same plane during the entire motion, we shall use but two axes, x and y ; taking the first horizontal, and the second vertical. Representing by X and Y the components of the resultant along the axes of x and y respectively, we have

$$D_{\xi}x = X, \quad D_{\eta}y = Y.$$

The hypothesis that X and Y are constant, gives the following integrals of the form [1], the quantities X and Y representing the function q :

$$\begin{aligned} a &= x'^2 - 2Xx, & b &= y'^2 - 2Yy, \\ a' &= Xt - x', & b' &= Yt - y. \end{aligned} \quad [10]$$

Since our integrals are taken on the hypothesis that X and Y are constant, we have

$$\delta X = D_{\xi}X, \quad \delta Y = D_{\eta}Y;$$

and the equation [5] gives for the variation of the parameters a, b, a', b' , when X and Y vary, the equations

$$\begin{aligned} D_{\xi}a &= -2x D_{\xi}X, & D_{\eta}b &= -2y D_{\eta}Y, \\ D_{\xi}a' &= t D_{\xi}X, & D_{\eta}b' &= t D_{\eta}Y. \end{aligned} \quad [11]$$

Putting g equal to the force of gravity, s the length of the

trajectory along which the body moves, ρ the density of the resisting medium, and m a constant factor depending on the weight and magnitude of the projectile, and supposing the resistance of the medium to be proportional to the square of the velocity, we have

$$X = -m\rho D_{\xi}D_{\xi}X, \quad Y = g - m\rho D_{\eta}D_{\eta}Y. \quad [12]$$

The ten equations [10], [11], [12] will just suffice to determine the ten quantities $x, y, x', y', a, a', b, b', X, Y$, in terms of the time, and of the circumstances of the original motion which will enter as arbitrary constants into the integrals of [11]. To integrate and resolve them simultaneously does not seem possible; but if we wished to integrate them by approximation, we might first determine the values of $x, y, D_{\xi}x, D_{\eta}y$, on the supposition that there was no resisting medium, which would furnish us with approximate values of X and Y from equations [12]. These values being substituted in the second members of [11] would give values of the parameters a, a', b, b' , the substitution of which in [10] would give a second approximation to the values of $D_{\xi}x, D_{\eta}y, x, y$; and by repeating the process, we might attain any degree of accuracy, provided that the relation between the volume, weight, and velocity of the body, and the density of the medium, be such that the series thus obtained would be convergent.

Let us next deduce some equations which will be applicable to the motions of the bodies of the solar system. If we consider $n+1$ bodies of which the masses are $m, m_1, m_2, \dots, m_n$, attracting each other according to the law of gravitation: if we put q_1, q_2 , etc. for their distances from the body m whose motion we consider; R_x, R_y, R_z , the forces acting on m , resolved in the direction of the axes of x, y, z respectively, and R their resultant, we have

$$\begin{aligned} R_x &= \sum_1^n m_i \frac{x_i - x}{q_i^3}, & R_y &= \sum_1^n m_i \frac{y_i - y}{q_i^3}, & R_z &= \sum_1^n m_i \frac{z_i - z}{q_i^3}; \\ R &= (R_x^2 + R_y^2 + R_z^2)^{\frac{1}{2}}. \end{aligned} \quad [13]$$

In the present case it will be better to remove the terms in the values of R_x, R_y, R_z , which relate to the sun, from under the sign Σ , and to have the masses m to refer only to the planets. We shall then be able to develop R and its functions in a series arranged according to the ascending powers of the masses of the planets divided by that of the sun; and at present we shall carry the series only to the first power of these quantities. If we put X, Y, Z for the coördinates of the sun, take its mass for the unity of mass, and call q its distance from the planet m , the values of R_x, R_y, R_z become

$$\begin{aligned} R_x &= \frac{X-x}{q^3} + \sum m_i \frac{x_i - x}{q_i^3}, & R_y &= \frac{Y-y}{q^3} + \sum m_i \frac{y_i - y}{q_i^3}, \\ R_z &= \frac{Z-z}{q^3} + \sum m_i \frac{z_i - z}{q_i^3}. \end{aligned} \quad [14]$$

Since the resultant is directed nearly to the sun, and its intensity is nearly equal to the attraction of the sun, we shall suppose it to be the effect of an attractive center, of the same mass as the sun, attracting according to the law of gravitation, as its distance from the center of gravity of the system, and consequently its motion will then be a very small quantity of the order of the masses of the planets. If we take the integrals on the supposition that the center of force remains at rest, they will be of the form [6]. Putting as in [6], ξ, η, ζ for the coördinates of the assumed center, we find that in order that its attraction on the planet m may be equal to that of all the bodies of the system, we must have

$$\xi = x + \frac{R_x}{R^{\frac{3}{2}}}, \quad \eta = y + \frac{R_y}{R^{\frac{3}{2}}}, \quad \zeta = z + \frac{R_z}{R^{\frac{3}{2}}}, \quad [15]$$

We shall now suppose the origin of coördinates to be so taken that X, Y, Z shall be of the order of the masses of the planets. Substituting in the value [13] of R for R_x, R_y and R_z , their values in [14]; developing to quantities of the first order, and putting for brevity

$$x \sum_1^n m_i \frac{x_i - x}{q_i^3} + y \sum_1^n m_i \frac{y_i - y}{q_i^3} + z \sum_1^n m_i \frac{z_i - z}{q_i^3} = A,$$

we find for the value of R ,

$$R = \frac{1}{q^2} - \frac{A}{q}. \quad [16]$$

By the substitution of the value of R , and the values [14] of R_x, R_y and R_z , we find for the coördinates of the center of force,

$$\begin{aligned} \xi &= X + q^3 \sum m_i \frac{x_i - x}{q_i^3} - \frac{3}{2} x q A, \\ \eta &= Y + q^3 \sum m_i \frac{y_i - y}{q_i^3} - \frac{3}{2} y q A, \\ \zeta &= Z + q^3 \sum m_i \frac{z_i - z}{q_i^3} - \frac{3}{2} z q A. \end{aligned} \quad [17]$$

These values may be put under the form

$$\begin{aligned} \xi &= X + q^3 D_x \sum \frac{m_i}{q_i} - \frac{3}{2} x q (x D_x + y D_y + z D_z) \sum \frac{m_i}{q_i}, \\ \eta &= Y + q^3 D_y \sum \frac{m_i}{q_i} - \frac{3}{2} y q (x D_x + y D_y + z D_z) \sum \frac{m_i}{q_i}, \\ \zeta &= Z + q^3 D_z \sum \frac{m_i}{q_i} - \frac{3}{2} z q (x D_x + y D_y + z D_z) \sum \frac{m_i}{q_i}. \end{aligned} \quad [18]$$

By taking for our fundamental integrals those of the elliptic motion, and substituting in the equations [7] these values of ξ, η and ζ , we could arrive at expressions for the inequalities in the motions of the planets produced by their mutual action; but the analysis would be complicated, and it does not seem probable that it would lead to any new result.

It has been proposed to compute the motion of a comet at a considerable distance without the orbits of any of the planets, by supposing it attracted to the centre of gravity of the solar

system by a force equal to the action of the sun and all the planets on it, if they were placed together at that point. The preceding values of ξ, η and ζ might furnish a more nearly accurate expression for the position of a fixed center toward which the comet might be considered as being attracted during a long period of time; by developing them in a series of sines and cosines of angles, and neglecting the periodic portion, the part of which corresponding to any particular planet we might suppose approximately to destroy itself during one revolution of the planet. To enter into a discussion of this subject would, however, be foreign to our present purpose.

It will be easy to deduce, by this method, expressions for the variations which would be produced in the elements of the orbits of the planets by a very rare resisting medium. Neglecting quantities of the order of the masses of the planets into the density of the medium, we may suppose that the only forces which act on the planet are the attraction of the sun and the resistance of the medium, and consider the sun as being fixed. We shall also neglect all quantities of the second or higher orders with respect to the density of the medium.

If we take the center of the sun for the origin of coördinates, its mass for the unity of mass, and put

$$r = \sqrt{x^2 + y^2 + z^2} = \text{radius-vector of planet};$$

the attraction of the sun on the planet, resolved in the direction of the axes of x, y, z respectively, will be

$$-\frac{x}{r^3}, \quad -\frac{y}{r^3}, \quad -\frac{z}{r^3}.$$

If we represent by ϱ the density of the medium, suppose its resistance to be proportional to the square of the velocity of the planet, and put s for the length of the curve along which the planet moves, the resistance of the medium to the motion of the planet, resolved in the directions of the coördinate axes, will be

$$-m \varrho D_s D_r x, \quad -m \varrho D_s D_r y, \quad -m \varrho D_s D_r z;$$

m being a factor, constant for each planet, and dependent on its volume and mass. We have, therefore, by calling X, Y, Z the components along the axes of all the forces which act on the planet,

$$\begin{aligned} X &= -\frac{x}{r^3} - m \varrho D_s D_r x, \\ Y &= -\frac{y}{r^3} - m \varrho D_s D_r y, \\ Z &= -\frac{z}{r^3} - m \varrho D_s D_r z, \end{aligned} \quad [19]$$

We shall now, as before, suppose these forces to be the effect of an attractive centre of the same mass with the sun, and acting according to the same law. Putting ξ, η, ζ for its coördinates, and

$r' = [(x - \xi)^2 + (y - \eta)^2 + (z - \zeta)^2]^{\frac{1}{2}}$ = its distance from the planet; its attraction on the latter, resolved in the direction of the axes of x, y, z respectively, will be

$$-\frac{x-\xi}{r^3}, \quad -\frac{y-\eta}{r^3}, \quad -\frac{z-\zeta}{r^3}.$$

Equating these values with the components of the resultant in [19], we have for the conditions to be fulfilled by ξ, η, ζ ,

$$\begin{aligned} \frac{x-\xi}{r^3} &= \frac{x}{r^3} + m \varrho D_t s D_t x, \\ \frac{y-\eta}{r^3} &= \frac{y}{r^3} + m \varrho D_t s D_t y, \\ \frac{z-\zeta}{r^3} &= \frac{z}{r^3} + m \varrho D_t s D_t z. \end{aligned} \quad [20]$$

Developing the first members of these equations, and neglecting all dimensions of ξ, η, ζ above the first, since these quantities are of the same order as the density of the resisting medium, we shall have

$$\begin{aligned} (3x^2 - r^2)\xi + 3xy\eta + 3xz\zeta &= m \varrho r^5 D_t s D_t x, \\ (3y^2 - r^2)\eta + 3yz\zeta + 3yx\xi &= m \varrho r^5 D_t s D_t y, \\ (3z^2 - r^2)\zeta + 3zx\xi + 3zy\eta &= m \varrho r^5 D_t s D_t z. \end{aligned} \quad [21]$$

From these, observing that by the value of r ,

$$x D_t x + y D_t y + z D_t z = r D_t r,$$

we obtain the following values of ξ, η, ζ :

$$\begin{aligned} \xi &= \frac{1}{2} m \varrho r^2 D_t s (3x D_t r - 2r D_t x), \\ \eta &= \frac{1}{2} m \varrho r^2 D_t s (3y D_t r - 2r D_t y), \\ \zeta &= \frac{1}{2} m \varrho r^2 D_t s (3z D_t r - 2r D_t z). \end{aligned} \quad [22]$$

We shall take our integrals on the hypothesis that the center of force remains at rest; as they will then be of the form [6], in which the quantities ξ, η, ζ enter in the most simple manner. If we differentiate with respect to the time the above values [22] of ξ, η and ζ , and substitute them in [7], equation [6], from which [7] is derived, being supposed to represent in succession the various integrals of the elliptic motion, we shall have expressions for the variations of the elements of the motion of the planet around the assumed center of force; but these elements not being those used for astronomical purposes, it will be better to apply corrections to them to make them equal to the latter. The assumed form of our integral is

$$a = f(x-\xi, y-\eta, z-\zeta, x', y', z', t).$$

The corresponding integral used for astronomical purposes, distinguishing its arbitrary constant by an accent, is

$$a' = f(x, y, z, x', y', z', t). \quad [22]'$$

Comparing these equations, we obtain

$$a' = a + \xi D_x a + \eta D_y a + \zeta D_z a + \frac{1}{2} \xi^2 D_{xx} a + \xi \eta D_{xy} a + \&c. \quad [23]$$

Differentiating this expression with respect to the time, neglecting quantities of the higher orders in ξ, η, ζ , and substituting for $D_t a$ its value in [7], we shall have for the general expression of the variations of the elements of the planet, omitting the accent on a ,

$$D_t a = \xi D_{x,t} a + \eta D_{y,t} a + D_{z,t} a. \quad [24]$$

The manner in which the differentiations indicated in the second member of this equation are to be performed, may easily be seen by observing the successive steps in its deduction. We first take the partial derivative of the constant with respect to x , the integral being supposed of the form [22]'; then the total derivative of this expression with respect to the time, this being the manner in which [23] is differentiated to obtain [24].

It may be remarked that the equation [24] is independent of the particular nature of the disturbing force, and applicable to every form of perturbation of which we neglect the higher dimensions.

The hypothesis of a body attracted toward the origin of coördinates by a force varying inversely as the square of the distance, furnishes the following well-known integrals of the elliptic motion:

$$\begin{aligned} c &= xy - x'y, \quad c' = yz - y'z, \quad c'' = zx' - z'x; \\ a &= \frac{r}{2 - r(x'^2 + y'^2 + z'^2)}; \quad \omega = v - \cos^{-1} \frac{k^2 - r}{er}; \\ l &= t - a^{\frac{3}{2}}(u - e \sin u); \end{aligned} \quad [25]$$

the five quantities r, v, k, e, u , being determined from the equations

$$\begin{aligned} r^2 &= x^2 + y^2 + z^2, \quad r' = \cos^{-1} \frac{x}{r}, \quad \cos u = \frac{a-r}{ae}, \\ k^2 &= c^2 + c'^2 + c''^2 = a(1 - e^2). \end{aligned} \quad [26]$$

If, by means of these five equations, we eliminate the above five quantities from the equations [25], the latter may be put into the form [22]':

The quantities c, c', c'' are proportional to the area described in a unit of time by the projection of the radius-vector of the planet on the planes of xy, yz, zx respectively; a is the semimajor axis of the orbit; ω , the longitude of the perihelion; and l , the epoch of the passage of the perihelion. Of the subsidiary quantities, k^2 is the semiparameter of the orbit, and u the eccentric anomaly. Let us now substitute the integrals in [24], that we may obtain expressions for the variations of the constants.

By differentiating c first with respect to the coördinates, and then with respect to the time, we have

$$D_{x,t} c = D_t y, \quad D_{y,t} c = -D_t x, \quad D_{z,t} c = 0.$$

Neglecting quantities of the order of the resistance, since these equations are to be multiplied by quantities of that order, we have

$$D_t y = -\frac{y}{r^3}, \quad D_t x = -\frac{x}{r^3};$$

whence

$$D_{x,t} c = -\frac{y}{r^3}, \quad D_{y,t} c = -\frac{x}{r^3}.$$

Multiplying the first of these last two equations by the value of ξ in [22], and the latter by that of η , and adding, we find

$$D_t c = -m q c D_t s. \quad [27]$$

Proceeding in a similar manner with c' and c'' , we should find

$$D_t c' = -m q c' D_t s, \quad D_t c'' = -m q c'' D_t s. \quad [28]$$

The quantities c , c' , c'' determine the position of the plane of the orbit, as well as the parameter of the ellipse. If we put i for the inclination of the orbit to the plane of xy , and Ω for the angle which its intersection with this plane makes with the axis of x , we shall have

$$\tan i = \frac{1}{c} \frac{c'^2 + c''^2}{c}, \quad \tan \Omega = -\frac{c'}{c''}. \quad [29]$$

Differentiating these expressions, and substituting the preceding values of $D_t c$, $D_t c'$, $D_t c''$, we find

$$D_t i = 0, \quad D_t \Omega = 0.$$

The position of the plane of the orbit is therefore invariable; and if we take it for the plane of xy , the quantities z , ζ and their derivatives will vanish. This we shall do, as it will simplify some of the analysis.

By differentiating the fourth of the integrals [25], we find

$$\begin{aligned} D_{x,t}^2 a &= \frac{2a^2}{r^3} D_t x - \frac{6a^2 x}{r^4} D_t r, \\ D_{y,t}^2 a &= \frac{2a^2}{r^3} D_t y - \frac{6a^2 y}{r^4} D_t r. \end{aligned} \quad [30]$$

Substituting these values in [24], and observing that

$$x D_t x + y D_t y = r D_t r, \quad D_t x^2 + D_t y^2 = D_t r^2 = \frac{2u-r}{ar},$$

we find

$$D_t \omega = D_c \omega D_t c + D_{k^2} \omega D_t k^2 + \nabla_1 r + D_r \omega \nabla_1 r + D_{c,t} \omega \nabla c + D_{k^2,t} \omega \nabla k^2 + D_{r,t} \omega \nabla r.$$

If we obtain the sum of all the terms of the righthand member of this equation, except the first two, we shall find it to vanish; a result at which we might arrive by *a priori* considerations. For, if we have an equation of the form

$$a = f(a', a'', \dots, x, y, z, t), \quad [34]$$

a' , a'' , etc. being arbitrary constants, and the second member not containing the derivatives of the coördinates explicitly, we have

$$0 = D_x a D_t x + D_y a D_t y + D_z a D_t z + (D_t a)$$

in the variable as well as the invariable orbit, since the first derivatives of the coördinates are the same in both orbits. It follows, then, that

$$D_t a = D_a a D_t a' + D_{a''} a D_t a'' + \dots \quad [35]$$

The above equation giving the value of ω being of the form [34], we have

$$D_t \omega = D_c \omega D_t c + 2k D_{k^2} \omega D_t k. \quad [36]$$

The theory of the elliptic motion gives the equation

$$D_t r^2 = \frac{a^2 e^2 - (a-r)^2}{a r^2}; \quad [37]$$

from which we obtain, by observing that $a(1-e^2) = k^2$,

$$D_t a = -2m q a^2 D_t s^3 = -2m q a^2 \left(\frac{2}{r} - \frac{1}{a} \right)^{\frac{3}{2}}. \quad [31]$$

The variation of the eccentricity will best be obtained from those of the semiparameter and mean distance. The differentiation of the fourth of equations [6] gives

$$D_t k = \frac{c D_t c + c' D_t c' + c'' D_t c''}{k}.$$

Substituting for the derivatives of c , c' and c'' their values in [27] and [28], this expression reduces to

$$D_t k = -m q k D_t s. \quad [32]$$

From the two last of equations [26], we obtain

$$e^2 = 1 - \frac{k^2}{a}.$$

Differentiating this expression, and substituting for $D_t k$ and $D_t a$ their values already found, we have for the variation of the eccentricity,

$$D_t e = 2m q D_t s \frac{k^2(r-a)}{a e r}. \quad [33]$$

It remains to find expressions for the motions of the perihelion and epoch. The fifth integral [25] is of the form

$$\omega = v - f(e, k^2, r).$$

If we use for brevity the functional notation

$$\xi D_x + \eta D_y = \nabla, \quad \xi D_{x,t} + \eta D_{y,t} = \nabla_1,$$

and observe that for any arbitrary constant we have $\nabla_1 = D_r$, we find

$$1 - \frac{(k^2 - r)^2}{e^2 r^2} = \frac{k^2 D_t r^2}{e^2}.$$

Differentiating the fifth of the integrals [25] with respect to k^2 and e , and substituting this value of $1 - \frac{(k^2 - r)^2}{e^2 r^2}$, we find

$$D_{k^2} \omega = \frac{1}{k r D_r}, \quad D_e \omega = \frac{r - k^2}{e k r D_r}. \quad [38]$$

We now have values of all the quantities which enter into the second member of [36], which becomes, after suitable reduction, by noticing the above value [37] of $D_t r$,

$$D_t \omega = -\frac{2m q k D_t s D_r}{e^2}. \quad [39]$$

The last of the integrals [25], which gives the epoch of a certain passage of the perihelion being of the form [34], we have

$$D_t l = \{(D_a l) + D_a l D_t a\} D_t a + \{(D_c l) + D_c l D_t c\} D_t c. \quad [40]$$

The differentiation of l with respect to a , e and u , gives

$$\begin{aligned} (D_a l) &= -\frac{3}{2} a^{\frac{1}{2}} (u - e \sin u) = \frac{3}{2} \frac{l - t}{a}, \\ (D_c l) &= a^{\frac{3}{2}} \sin u = \frac{a r D_t r}{e}, \\ (D_u l) &= a^{\frac{3}{2}} (1 - e \cos u) = -a^{\frac{1}{2}} r; \end{aligned} \quad [41]$$

the fourth and sixth equations being obtained by substituting for u its value [26], observing the above value of D_r . The differentiation of the last-mentioned value of u gives

$$D_t l = m \varrho D_s \left[\left(3(l-t) + 2 \frac{r}{D_r} \right) \left(1 - \frac{2a}{r} \right) + \frac{2k^2(r-a)(arD_r^2 - r-a)}{a^2 r D_r} \right]. \quad [42]$$

This expression will take a more simple form, if we substitute for the variables in it their values in terms of the eccentric anomaly u . From the third equation [26] we obtain, by observing the expression [37],

$$D_t l = m \varrho D_s \left[3(t-l) \frac{1+e \cos u}{1-e \cos u} + \frac{2a^{\frac{3}{2}} \sin u}{e(1-e \cos u)} (e^2 \cos u - 1) \right]. \quad [43]$$

The element l is, however, seldom used by astronomers, except for bodies moving in a parabola. For the planets, the mean longitude at a fixed epoch in the instantaneous orbit is more commonly used to determine the position of the planet in its orbit. If we put ε for this element, the theory of the elliptic motion gives

$$nt + e - \omega = u - e \sin u = n'(t-l);$$

$$D_t \varepsilon = \frac{2m \varrho D_s \sin u}{e(1-e \cos u)} (1 - 1 - e^3 - e^3 \cos u) - \frac{3m \varrho D_s}{a^{\frac{3}{2}}(1-e \cos u)} \cdot \frac{1+e \cos u}{1-e \cos u}. \quad [44]$$

The integral of the last portion of this equation is usually added to the quantity nt , which causes the mean longitude in the disturbed orbit to become equal to $\int n dt + \varepsilon$: otherwise when t became very large, ε would be subject to great changes in value.

The various expressions which have been deduced for the

$$D_a u = -\frac{1}{a^{\frac{3}{2}} D_r}, \quad D_r u = \frac{a-r}{a^{\frac{1}{2}} e r D_r}.$$

Equation [40] now becomes

$$\sin u = \frac{r D_r}{a^{\frac{1}{2}} e}; \quad D_r = \frac{e \sin u}{a^{\frac{1}{2}} (1-e \cos u)}.$$

Substituting in [42] this value of D_r , and also that of r in terms of the eccentric anomaly, it reduces to

where n represents the mean motion of the planet, and is equal to $a^{-\frac{3}{2}}$ when the mass of the latter is neglected. From these equations we obtain

$$D_t \varepsilon = D_t \omega - a^{-\frac{3}{2}} D_t l + \frac{3}{2} l a^{-\frac{5}{2}} D_t a.$$

If we substitute for the quantities in the second member of this equation their values in terms of the eccentric anomaly, we find

variations in the elements of the orbits of the planets which would be produced by a resisting medium, are equivalent to those given by LAGRANGE in the *Mécanique Analytique*, and by PONTECOULANT in the *Système du Monde*.

Nautical Almanac Office, 1858 Feb. 12.

FROM LETTERS OF PROFESSOR ARGELANDER TO THE EDITOR.

Bonn, 1858 March 12.

I HAVE no time to add more than to announce to you the discovery of a new comet which was found by Dr. WINNECKE on the 8th instant at 14^h. The positions found up to date are the following:

	Bonn M.T.	$\angle \alpha$	$\angle \delta$
1858 March 8	16 ^h 16 ^m 56 ^s	258° 56' 24.8	—1° 54' 7.3
	16 54 57	58 47.8	54 14.6
11	16 2 35	264 14 17.1	58 39.8
	16 28 21	16 15.2	—1 58 36.6

The first two observations were taken with the ring-micrometer: the last two with the heliometer.

Possibly this information may reach you in season to permit of some observations in the United States.

Bonn, 1858 March 16.

I WRITE this second letter so soon, in order to send you as early as possible the important information that the comet found by Dr. WINNECKE is a periodic one, being the Comet 1819 III, for which ENCKE had formerly found an ellipse of 5.6 years, but without being able to determine the probable

uncertainty of this period, on account of the insufficiency and short duration of the observations. From the observations March 8, 11 and 12, Dr. KRÜGER had determined a system of elements, which much resemble those of that comet; and when WINNECKE consequently tried to represent the present observations by means of the elements of the former comet, he found an almost perfect agreement by putting the perihelion May 1.985 and increasing the inclination by only 6.8. There has consequently been no difficulty whatever in basing an ephemeris upon these elements, and I copy for you the last portion.

Bonn Mean Midnight.	$\angle \alpha$	$\angle \delta$	$\log \Delta$	$\log r$
1858 March 25	291° 22'	—2° 5'	9.7333	9.9955
26	293 24	4		
27	295 26	4		
28	297 27	3		
29	299 27	1	9.7383	9.9785
30	301 26	2 0		
31	303 24	1 58		
April 1	305 21	56		
2	307 17	—1 54	9.7494	9.9615

OBSERVATIONS OF THE ALGOL-MINIMA OF JANUARY 21 AND MARCH 5, 1858,

MADE AT WASHINGTON (D. C.), BY CHARLES A. SCHOTT,

ASSISTANT U. S. COAST SURVEY.

JANUARY 21.

Atmosphere clear; moon bright, but not interfering with the observations.

Time by Watch.	Comparisons.		
$8^h 37^m$	$\delta = \beta$	β	1ϱ
43	=		1
49	$\frac{1}{4}$	$\frac{1}{2}$	
55	$\frac{1}{4}$	$\frac{1}{2}$	
9 1	$\frac{1}{4}$	$\frac{1}{4}$	
7	$\frac{1}{4}$	$\frac{1}{4}$	
13	$\frac{1}{4}$	$\frac{1}{4}$	
19	$\frac{1}{4}$	=	nearly
25	=	=	"
31	$\frac{1}{2}$	=	"
37	$\frac{1}{2}$	=	" , hazy
43	$\frac{1}{2}$	$\frac{1}{4}$	hazy
49	$\frac{1}{2}$	$\frac{1}{4}$	clear
55	$\frac{1}{4}$	$\frac{1}{2}$	
10 1	$\frac{1}{4}$	$\frac{1}{2}$	
7	$\frac{1}{4}$	$\frac{3}{4}$	
13	$\frac{1}{4}$	$\frac{3}{4}$	
19	=	1	hazy
25	$\delta = \beta$	β	1ϱ "

δ		ϱ	
by $\frac{1}{2}$	$9^h 37^m 0$	$9^h 28^m 0$	by =
$\frac{1}{4}$	34 .0	28 .0	$\frac{1}{4}$
=	31 .0	26 .5	$\frac{1}{2}$
		28 .0	$\frac{3}{4}$
		31 .0	1
Means	$9^h 34^m 0$	$9^h 28^m 3$	
	$9^h 31^m 15$		
Watch fast	11 .75		
Minimum	$9^h 19^m 4$	Washington M.T.	

MARCH 5.

Sky clear.

Time by Watch.	Comparisons.		
$8^h 59^m$	$\delta = \beta$	β	$\frac{1}{2} \varrho$
9 5	=		$\frac{1}{2}$
11	$\frac{1}{4}$	$\frac{1}{2}$	
17	$\frac{1}{4}$	$\frac{1}{4}$	
23	$\frac{1}{4}$	$\frac{1}{4}$	
29	$\frac{1}{2}$	=	nearly
35	$\frac{3}{4}$	=	"
41	$\frac{3}{4}$	=	"
47	$\frac{1}{2}$	$\frac{1}{4}$	
53	$\frac{1}{2}$	$\frac{1}{4}$	
59	$\frac{1}{2}$	$\frac{1}{4}$	
10 5	$\frac{1}{2}$	$\frac{1}{4}$	
11	$\frac{1}{4}$	$\frac{1}{4}$	
17	=	$\frac{1}{2}$	
23	a slight haze spreading over β and ϱ , the observations were discontinued.		

δ		ϱ	
by $\frac{3}{4}$	$9^h 38^m 0$	$9^h 35^m 0$	by =
$\frac{1}{2}$	42 .5	39 .5	$\frac{1}{4}$
$\frac{1}{4}$	44 .0	44 .0	$\frac{1}{2}$
=	41 .0		
Means	$9^h 41^m 4$	$9^h 39^m 5$	
	$9^h 40^m 4$		
Watch fast	0 .2		
Minimum	$9^h 40^m 2$	Washington M.T.	

NOTICE.

THE observation of the four asteroids, *Vesta*, *Iris*, *Eunomia* and *Amphitrite*, for which the Editor assumed the responsibility in N° 96 of this Journal, has been undertaken by LEWIS M. RUTHERFORD, Esq., at his private observatory in the City of New-York.

Albany, 1858 March 10.

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ON A METHOD IN DYNAMICS : BY MR. SIMON NEWCOMB.
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NOTICE.

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ALBANY, 1858, MAY 20.

NO. 17.

OBSERVATIONS OF THE COMETS 1857 IV AND 1857 V, LETITIA, VIRGINIA, HESTIA, AGLAIA, AND CALLIOPE.

MADE AT ANN-ARBOR, MICHIGAN, WITH THE FILAR-MICROMETER OF THE EQUATORIAL.

BY JAMES C. WATSON.

[Communicated by Professor BREXNOW.—Corrected for refraction.]

FOURTH COMET OF 1857.

Date.	Ann-Arbor M.T.	No. Comp.	Comparison-Star.	— *		's apparent	
				<i>Aa</i>	<i>Aδ</i>	<i>a</i>	<i>δ</i>
1857 Aug. 3	^h 15 ^m 7 ^s 3.3	7	* 1	^m + 0 52.57	^s — 0 25.4	^h 5 7 ^m 43.05	^s + 49 16 55.6
3	15 36 20.5	4	Argelander's Z. 76,12	— 1 54.76	+ 2 8.5	5 7 53.11	49 15 47.7
5	14 34 36.5	6	" 87,135	— 3 35.81	— 3 51.2	5 23 10.30	46 39 47.8
6	13 30 22.1	3	" 70,129	+ 1 40.62	+ 0 11.5	5 30 11.04	45 21 58.0
6	14 11 27.0	3	" 70,129	+ 1 52.05	— 2 28.1	5 30 22.47	45 19 18.4
6	14 34 19.1	5	" 70,129	+ 1 58.86	— 3 35.9	5 30 29.28	45 18 10.6
6	15 2 31.1	4	" 70,129	+ 2 7.18	— 5 1.8	5 30 37.60	45 16 44.7
10	14 26 9.5	3	Bessel's Z. 509,39	— 0 51.41	— 4 13.9	5 56 37.71	39 45 9.3
10	15 30 20.6	3	" 509,38	— 0 7.13	— 3 35.1	5 56 51.18	39 41 30.7
10	15 37 23.0	2	" 509,43	— 2 29.20	— 1 26.5	5 56 55.98	39 40 55.0
12	15 19 3.1	4	" 490,16	+ 0 45.61	— 2 14.9	6 8 25.95	36 53 38.3
12	15 40 32.9	4	" 490,16	+ 0 51.51	— 3 12.3	6 8 31.85	36 52 40.9
18	14 27 35.7	6	" 520,106	+ 1 17.76	+ 3 39.7	6 38 37.63	28 45 14.4
18	14 27 35.7	6	" 520,107	+ 1 0.78	+ 2 51.3	6 38 37.64	28 45 14.0
18	15 8 58.6	4	" 520,106	+ 1 25.73	+ 1 16.8	6 38 45.60	28 42 51.5
18	15 8 58.6	4	" 520,107	+ 1 8.78	+ 0 22.7	6 38 45.64	28 42 45.4
18	15 40 17.8	9	* 2	— 1 27.49	— 0 38.1	6 38 51.23	28 41 19.4
19	14 34 1.3	5	Bessel's Z. 520,109	+ 2 56.38	+ 5 28.4	6 43 11.78	27 26 25.6
19	15 26 18.6	9	" 520,109	+ 3 6.60	+ 2 33.2	6 43 22.00	27 23 30.4
20	14 49 46.5	12	" 405,131	+ 0 15.03	— 0 25.9	6 47 42.13	26 8 6.7
20	15 54 48.7	8	" 405,131	+ 0 27.20	— 3 59.3	6 47 51.30	26 4 33.3
23	15 0 45.3	4	" 279,63	+ 0 41.15	— 1 22.7	7 0 26.87	22 23 28.2
23	15 41 58.0	8	<i>δ Geminorum</i>	— 11 1.79	+ 7 2.6	7 0 34.46	22 21 38.8
24	15 52 7.4	14	Bessel's Z. 279,73	+ 0 29.51	— 3 8.6	7 4 39.79	21 9 8.2
25	15 28 38.8	6	" 277,45	— 2 52.43	+ 2 20.1	7 8 34.81	20 0 16.1
29	15 9 16.4	6	" 276,232	+ 4 24.92	— 0 34.7	7 23 43.85	15 35 34.4
30	15 21 57.9	8	" 146,243	+ 1 1.26	+ 7 55.9	7 27 23.97	14 32 30.2
30	15 57 52.2	5	" 62,3	— 6 31.60	— 1 28.8	7 27 29.38	14 31 0.6
31	15 41 21.9	5	* 3	— 3 57.92	+ 0 16.4	7 31 2.22	13 30 36.1
31	16 12 39.4	4	* 4	— 0 39.52	+ 4 34.4	7 31 6.79	13 29 33.6
31	16 12 39.4	4	* 5	— 1 37.48	+ 4 39.1	7 31 6.63	13 29 32.8
Sept. 1	16 5 18.7	4	Bessel's Z. 148,136	+ 5 40.55	+ 6 35.9	7 34 36.64	12 30 20.1
7	15 55 23.3	5	* 6	+ 1 15.20	+ 0 49.6	7 54 38.20	+ 7 4 9.9
9	15 41 47.4	5	* 7	+ 1 23.51	— 1 20.8		
9	16 8 5.0	4	* 8	— 0 14.31	— 3 30.5		
23	15 48 4.8	3	Bessel's Z. 223,19	+ 4 27.37	— 5 27.5	8 39 57.10	— 3 59 21.8
23	16 14 16.4	7	" 223,29	— 1 30.91	— 0 14.5	8 40 0.11	3 59 58.9
23	16 34 29.4	3	" 223,24	+ 0 45.27	+ 2 41.8	8 40 1.49	4 0 20.4
24	16 14 31.5	4	* 9	+ 5 12.87	+ 1 13.1	8 42 27.84	4 33 30.3
24	16 36 14.3	2	* 10	+ 3 24.50	+ 3 32.2	8 42 30.13	4 34 15.3
25	16 2 58.1	4	Bessel's Z. 223,31	+ 2 13.89	+ 2 53.9	8 44 52.56	— 5 7 0.5

The observations until August 18, and after September 1, were taken with the ring-micrometer. During this time the comet was rendered so extremely faint by the bright moonlight that it would not bear the slightest illumination; being very much diffused and ill-defined, without any marked concentration of light at the center.

Adopted Mean Places 1857.0 of Comparison-Stars.

*	Mag.	α			δ			Authority.
		^h	^m	^s	[°]	[']	["]	
Argelander's Z. 71,127	8.9	5	6	26.31	+	49	10 46.4	Argelander's Zones.
* 1	9.0	5	6	49.05		49	17 17.6	Equat. from Arg. Z. 71,127.
Argelander's Z. 76,12	9	5	9	46.41		49	13 35.8	Argelander's Zones.
" 87,135	8	5	26	41.67		46	43 35.2	"
" 70,129	8	5	28	28.95		45	21 42.4	"
Bessel's Z. 509,39	9	5	57	30.65		39	49 17.9	Bessel's Zones.
" 509,38	9	5	56	59.81		39	45 0.5	"
" 509,43	9	5	59	23.71		39	42 16.2	"
" 490,16	9	6	7	38.81		36	55 47.6	"
" 520,106	9	6	37	18.37		28	41 28.1	"
" 520,107	9	6	37	35.36		28	42 16.2	"
* 2	8	6	40	17.22		28	41 51.0	Equat. from B. Z. 520,106.
Bessel's Z. 520,109	7.8	6	40	13.90		27	20 50.5	Bessel's Zones.
" 405,131	9	6	47	25.60		26	8 25.7	"
" 279,63	9	6	59	11.23		22	24 43.8	"
δ Geminorum	3	7	11	34.81		22	14 29.5	Am. Naut. Almanac 1857.
Bessel's Z. 279,73	8	7	4	8.80		21	12 9.5	Bessel's Zones.
" 277,45	9	7	11	25.77		19	57 48.6	"
" 276,232	7.8	7	19	17.45		15	36 1.3	"
" 146,243	8.9	7	26	21.23		14	24 26.4	"
" 62,3	7	7	33	39.50		14	32 21.5	"
* 3	9	7	31	58.65		13	30 11.7	Equat. from B. Z. 62,5.
* 4	9.0	7	31	41.82		13	24 51.2	"
* 5	9	7	32	42.62		13	24 45.7	"
Bessel's Z. 62,5	9	7	31	28.02		13	34 35.5	Bessel's Zones.
" 148,136	8.9	7	28	51.60		12	23 36.2	"
* 6	9.0	7	53	21.51	+	7	3 12.4	Meridian Circle—Professor Brünnow.
Bessel's Z. 223,19	7	8	35	28.32	—	3	54 1.2	Bessel's Zones.
" 223,29	8	8	41	29.61		3	59 51.3	"
" 223,24	9	8	39	14.81		4	3 9.1	"
* 9	8.9	8	37	13.57		4	34 50.6	Meridian Circle—Professor Brünnow.
* 10	9	8	39	1.23		4	37 54.7	"
Bessel's Z. 223,31	7.8	8	42	37.21	—	5	10 1.4	Bessel's Zones.

FIFTH COMET OF 1857.

Date.	Ann Arbor M.T.	No. Comp.	Comparison-Star.	$\zeta - *$		ζ 's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	[°] ['] ["]
1857 Sep. 10	8 11 20.7	4	Bessel's Z. 414,16	—3 33.59	+ 1 14.9	13 42 54.40	+ 34 7 39.5
10	8 44 5.6	6	" 414,23	+2 4.99	+ 3 23.3	13 42 55.98	34 4 48.8
11	7 59 29.4	5	" 413,15	+2 31.41	+ 1 3.5	13 44 3.46	32 10 26.1
11	7 59 29.4	5	" 413,16	+2 8.90	+ 3 34.8	13 44 3.68	32 10 26.0
14	8 33 41.6	5	* 1	+0 53.38	— 4 13.2	13 46 28.57	26 45 59.7
14	8 47 16.7	4	Bessel's Z. 462,64	—1 19.18	— 8 0.9	13 46 29.11	26 45 4.2
20	7 54 15.4	4	B. A. C. 4597	+6 59.45	— 7 22.5	13 47 28.63	18 2 17.7
22	7 46 10.6	5	Bessel's Z. 288,14	+4 0.26	— 1 34.2	13 46 58.72	15 34 29.5
23	7 22 8.6	5	" 85,25	—0 30.18	— 7 23.5	13 46 35.78	14 21 55.5
23	7 22 8.6	5	" 85,28	—2 27.54	— 2 0.6	13 46 35.66	14 25 2.0
24	7 4 18.4	5	" 85,23	—0 9.82	— 9 15.1	13 46 8.71	13 17 34.4
24	7 4 18.4	5	" 85,24	—0 37.60	— 5 34.9	13 46 8.72	+ 13 17 35.7

Adopted Mean Places for 1857.0 of Comparison-Stars.

*	Mag.	α			δ			Authority.
		h	m	s	°	'	"	
Bessel's Z. 414,16	8.9	13	46	26.86	+	31	6 28.4	Bessel's Zones.
" 414,23	8	13	40	49.86		31	1 29.3	"
" 413,15	8.9	13	41	30.90		32	9 26.9	"
" 413,16	8	13	41	53.66		32	6 55.5	"
* 1	8.9	13	45	31.05		26	50 18.2	Equat. from B. Z. 462,56.
Bessel's Z. 462,56	8.9	13	43	47.62		27	0 3.2	Bessel's Zones.
" 462,64	8	13	47	47.15		26	53 10.4	"
B. A. C. 4597	5	13	40	28.03		18	10 16.6	Greenwich Twelve Y. Catalogue.
Bessel's Z. 288,14	9	13	42	57.31		15	36 11.1	Bessel's Zones.
" 85,25	8.9	13	47	4.81		11	32 26.7	"
" 85,28	8	13	49	2.05		14	27 10.3	"
" 85,23	7	13	46	17.36		13	26 57.5	"
" 85,24	8	13	46	15.15	+	13	23 18.6	"

LETTIA.

Date.	Ann Arbor M. T.	No. Comp.	Comparison-Star.	③9 — *		③9's apparent	
				α	δ	α	δ
1857 July 23	10 33 24.0	3	Bessel's Z. 167,73	—1 39.80	+ 1 6.3	15 50 24.22	— 6 52 31.5
" 24	10 58 20.1	5	" 167,73	—1 32.48	— 3 59.7	15 50 31.54	6 57 37.5
" 25	9 56 22.1	15	* 1	—1 28.90	— 1 35.3	15 50 40.38	7 2 29.8
" 28	10 50 42.6	17	* 2	+0 35.42	— 2 46.7	15 51 18.83	7 18 19.8
" 29	10 47 50.4	17	* 2	+0 50.66	— 8 12.7	15 51 33.97	7 23 45.8
" 31	11 30 54.5	20	Bessel's Z. 170,46	—0 6.26	— 6 17.3	15 52 8.28	7 34 59.7
Aug. 1	9 59 59.0	10	" 170,43	+1 30.44	— 7 22.5	15 52 26.14	— 7 40 16.9

Adopted Mean Places 1857.0 of Comparison-Stars.

*	Mag.	α			δ			Authority.
		h	m	s	°	'	"	
Bessel's Z. 167,73	7	15	52	1.55	—	6	53 28.0	Bessel's Zones.
* 1	9.0	15	52	6.81		7	0 44.7	Equat. from B. Z. 167,73.
* 2	9	15	50	40.97		7	15 23.0	" 170,47.
Bessel's Z. 170,47	8	15	52	41.37		7	23 57.4	Bessel's Zones.
" 170,46	8.9	15	52	12.11		7	28 32.2	"
" 170,43	9	15	50	53.27	—	7	32 44.1	"

VIRGINIA.

Date.	Ann Arbor M. T.	No. Comp.	Comparison-Star.	⑤0 — *		⑤0's apparent	
				α	δ	α	δ
1857 Oct. 14	11 53 10.0	7	* 1	+2 13.23	— 2 9.4	0 50 56.34	+ 2 52 6.2
" 16	8 3 22.1	5	* 2	—1 1.76	+ 1 3.0	0 49 49.95	2 41 2.0
" 16	11 2 20.7	6	* 2	—4 6.57	+ 0 18.5	0 49 45.14	2 40 17.5
" 17	9 32 32.9	6	Bessel's Z. 36,151	+3 2.02	+ 2 49.7	0 49 12.40	2 34 47.2
" 26	11 3 31.5	5	" 36,137	+7 28.60	+ 0 14.0	0 41 44.55	1 49 57.3
" 27	10 33 59.0	6	* 3	+3 27.85	+ 0 1.5	0 41 22.41	+ 1 46 9.6
Nov. 4	10 13 24.3	3	* 4	+6 20.07	+ 6 44.5		
" 5	8 56 16.7	8	* 5	+3 9.69	+ 2 46.9		

Adopted Mean Places 1857.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
* 1	9.0	0 48 39.56	+ 2 53 50.4	Meridian Circle— Professor Brünnow.
* 2	9	0 53 48.16	2 39 33.8	"
Bessel's Z. 36,151	9	0 46 6.72	2 31 32.4	Bessel's Zones.
" 36,137	9.0	0 37 12.30	1 49 18.5	Meridian Circle— Professor Brünnow.
* 3	9	0 40 50.91	+ 1 45 43.3	"

HESTIA.

Date.	Ann-Arbor M.T.	No. Comp.	Comparison-Star.	46 — *		46's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	[°] ['] ["]
1857 Oct. 16	10 13 51.5	6	Argelander's Z. 244,79	+3 4.77	+ 2 14.2	20 31 53.34	— 17 27 52.4
17	8 3 35.5	4	" 244,79	+4 6.15	+ 4 32.5	20 32 54.70	17 25 34.1
20	8 59 27.7	9	" 244,89	+0 28.07	— 1 14.6	20 36 19.35	17 17 35.1
21	9 15 33.8	7	" 244,89	+1 36.10	+ 1 37.2	20 37 27.37	— 17 14 43.3

Adopted Mean Places 1857.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
Argelander's Z. 244,79	9.0	20 28 45.48	— 17 30 10.2	Argelander's Zones.
" 244,89	9.0	20 35 48.21	— 17 16 24.6	"

AGLAIA.

Date.	Ann-Arbor M.T.	No. Comp.	Comparison-Star.	47 — *		47's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
	^h ^m ^s			^m ^s	[°] ['] ["]	^h ^m ^s	[°] ['] ["]
1857 Oct. 21	12 39 12.3	3	Lalande 46453	+ 2 5.90	+ 5 30.2	23 37 10.59	— 2 11 44.8
26	10 42 14.7	19	"	+ 0 19.92	+ 3 35.8	23 35 25.57	2 13 39.4
27	8 17 3.8	27	"	+ 0 4.63	+ 3 38.2	23 35 9.27	2 13 37.1
28	7 20 14.4	5	"	— 0 10.52	+ 3 43.4	23 34 54.12	2 13 31.8
Nov. 1	7 47 51.4	6	"	— 0 59.08	+ 5 40.4	23 34 5.54	2 11 35.1
3	7 19 16.5	7	Bessel's Z. 112,90	+ 0 36.73	— 1 4.1	23 33 50.65	2 9 54.9
3	8 3 41.6	3	Lalande 46453	— 1 14.23	+ 7 25.7	23 33 50.38	2 9 49.7
4	8 3 56.5	20	Bessel's Z. 112,90	+ 0 30.95	+ 0 8.3	23 33 44.86	2 8 42.5
5	7 56 40.4	11	" 112,90	+ 0 27.51	+ 1 24.0	23 33 41.44	— 2 7 26.7

Adopted Mean Places 1857.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
Lalande 46453	8.9	22 35 1.16	— 2 17 36.7	Meridian Circle— Professor Brünnow.
Bessel's Z. 112,90	9.0	23 33 10.53	— 2 9 12.0	Bessel's Zones.

CALLIOPE.

Date.	Ann Arbor M.T.	No. Comp.	Comparison-Star.	②② — *		②②'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 Jan. 2	^h 9 ^m 47 ^s 51.1	14	Bessel's Z. 398,105	— 0 4.25	— 2 17.3	^h 4 ^m 52 ^s 42.58	+29 24 14.9
	4 9 57 5.8	13	.. 398,105	— 1 33.57	+ 2 12.0	4 51 13.27	29 28 44.3
	9 11 22 33.6	6	Lalande 9259	— 1 22.95	+ 1 30.3	4 47 57.41	29 39 5.7
	9 11 22 33.6	6	.. 9276	— 1 49.50	+ 1 36.0	4 47 57.62	+29 39 7.1

Adopted Mean Places 1858.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
Bessel's Z. 398,105	8.9	^h 4 ^m 52 ^s 45.31	+29 26 20.5	Bessel's Zones.
Lalande 9259	9	4 49 18.85	29 37 23.2	Lalande's Catalogue.
.. 9276	8	4 49 45.61	+29 37 18.9	..

OBSERVATIONS OF COMET 1857 IV, MELPOMENE, AMPHITRITE, NEMAUSA AND EUROPA,

MADE WITH THE FILAR MICROMETER OF THE WASHINGTON EQUATORIAL,

By JAMES FERGUSON.

[Communicated by Lieutenant MAURY.— Corrected for refraction.]

COMET 1857 IV.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	④ — *		④'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1857 Aug. 21	^h 14 ^m 57 ^s 55.5	7	* 1	— 0 11.29	+12 25.15	^h 6 ^m 51 ^s 58.89	+24 54 4.53
	23 14 41 22.1	5	* 2	— 0 51.36	— 9 33.03	7 0 5.72	22 25 51.85
	29 15 7 57.2	10	B. Z. 276, 245	+ 0 9.62	+ 0 2.10	7 23 38.82	+15 36 45.78

* These observations (the places of *1 and *2 being undetermined) have been already published in No. 107 of this journal.

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
* 1	8.9	^h 6 ^m 52 ^s 19.70	Wash. Equatorial.	+24 40 18.52	Y ² .
* 2	8	7 1 6.21	Wash. Equatorial.	+22 35 1.99	Washington Equatorial.
B. Z. 276, 245	8	7 23 38.00	Bessel's Zones.	+15 36 14.63	Y ² .

MELPOMENE.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	⑮ — *		⑮'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 Mar. 10	^h 9 ^m 42 ^s 37.5	12	B. A. C. 4168	+ 1 24.72	+ 1 55.37	^h 12 ^m 16 ^s 45.95	+6 7 23.03
	11 8 44 46.3	11	..	+ 0 36.01	+10 46.16	12 15 57.08	6 16 14.37
	12 9 14 57.8	10	Weisse XII. 193	+ 2 21.02	— 1 40.96	12 15 6.59	6 25 38.15
	18 10 32 10.3	12	.. 144	— 0 30.24	— 2 19.34	12 9 43.64	7 20 56.72
	24 8 21 44.6	24	.. 49	+ 0 5.57	+ 2 40.12	12 4 23.62	8 12 2.31
	26 8 43 22.4	4	.. 49	— 1 42.77	+19 19.80	12 2 35.70	8 28 41.05
	29 8 20 10.6	9	.. 16	— 2 34.55	— 5 48.19	11 59 58.51	+8 52 8.93

Adopted Mean Places for 1860.0 of Comparison-Stars.

*	Mag.	α			Authority.	δ			Authority.	
		^h	^m	^s		[°]	[']	["]		
B. A. C. 4168	6.5	12	15	25.21	B. A. C. Struve C. Gen.	+	6	5	2.76	Y ² .
Weisse XII. 193	8	12	12	49.45	Rümker's Catalogue.		6	26	53.36	Y ² .
.. 144	8	12	10	17.78	Rümker's Catalogue.		7	22	50.59	Y ² .
.. 49	8.5	12	1	22.32	Weisse's Catalogue.		8	8	56.24	Y ² .
.. 16	9	12	2	36.88	Santini's Catalogue.	+	8	57	29.78	Y ¹ .

AMPHITRITE.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	(29) — *		(29)'s apparent	
				α	δ	α	δ
1858 Mar. 24	^h 9 ^m 19 ^s 47.5	12	Weisse XII. 402	^m — 0 ^s 52.70	['] — 3 ["] 8.82	^h 12 ^m 23 ^s 30.13	[°] — 4 ['] 19 ["] 33.09
29	9 56 32.0	9	" 291	+ 0 11.53	+ 3 34.71	12 18 45.47	4 1 6.17
30	9 31 30.6	17	" 291	— 0 43.74	+ 7 12.72	12 17 50.21	3 57 28.26
31	9 28 27.7	5	" 291	— 1 39.52	+ 10 52.55	12 16 54.43	— 3 53 48.53

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
		^h ^m ^s		[°] ['] ["]	
Weisse XII. 402	8.5	12 24 26.86	Weisse's Catalogue.	— 4 16 49.06	Y ² .
" 291	9	12 18 37.94	"	— 4 5 5.80	Y ¹ .

Y, in the column of Authorities, indicates that the declinations have been observed by Professor YARNALL with the Mural of this Observatory.

NEMUSIA.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	Planet — Star		Apparent	
				α	δ	α	δ
1858 May 13	^h 9 ^m 40 ^s 38.2	10	Weisse XI. 381	^m — 0 ^s 14.25	['] + 5 ["] 44.00	^h 11 ^m 21 ^s 50.68	[°] + 8 ['] 28 ["] 31.50

EUROPA.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	Planet — Star		Apparent	
				α	δ	α	δ
1858 May 13	^h 9 ^m 0 ^s 52.19	10	Rümker 3203	^m — 0 ^s 45.27	['] — 15 ["] 24.99	^h 10 ^m 20 ^s 5.87	[°] + 16 ['] 13 ["] 16.01

Adopted Mean Places 1860.0 of Comparison-Stars.

Authority.	α	δ
Weisse XI. 381	11 ^h 22 ^m 12.92	+ 8 [°] 22' 17.18
Rümker 3203	10 20 55.82	+ 16 28 8.03

LETTER FROM W. C. BOND, ESQ., TO THE EDITOR.

Harvard College Observatory, 1858 May 7.

I HAVE the pleasure to send you places of the third comet of 1858. It was discovered at this Observatory by Mr. HORACE TUTTLE on the evening of the 2^d instant: it is a very faint object. The stars observed with it on that evening have not yet been identified.

Cambridge M.T.		α	δ
1858 May 3	10 ^h 46 ^m 15.5	9 ^h 52 ^m 2.41	+ 35 [°] 6' 39.4
Star of Comparison, 10 mag.		9 52 6.58	+ 35 8 48.4
1858 May 4	8 ^h 52 ^m 23.3	9 56 43.21	+ 35 27 49.7
Star of Comparison, 8 mag.		9 57 15.03	+ 35 22 45.4
<i>Mean Equinox 1858.0.</i>			

W. C. BOND.

FIFTY-FIRST AND FIFTY-SECOND ASTEROIDS.

M. LE VERRIER has kindly communicated the following observations of these bodies :

N E M A U S A.

Place.	Date.	M.T. of Place.	α	δ	No. Comp.	Observer.
Bilk Paris	1858 March 5	^h ^m ^s 8 16 40.3	^h ^m ^s 11 44 37.49	[°] ['] ["] + 0 10 19.2	6	Luther.
	" 9	11 52 43.2	11 41 27.44		3	Besse-Bergier.
	" 9	12 13 8.9		+ 0 56 33.3	1	"
	" 9	15 27 22.3	11 41 20.28		3	"
	" 9	15 38 31.3		+ 0 58 15.1	3	"
Vienna	" 11	13 51 1.0	11 40		4	"
	" 11	13 59 10.7		+ 1 20	3	"
	" 18	9 33 39.6	11 34 22.81			Hornstein.
	" 18	9 49 4.5	11 34 22.35	+ 2 38 30.2		"

E U R O P A.

Place.	Date.	M.T. of Place.	α	No. Comp.	δ	No. Comp.	Observer.
Paris	1858 Feb. 6	^h ^m ^s 11 39 8.7	^h ^m ^s 10 49 40.19	5	[°] ['] ["] + 12 15 2.2	4	Lépissier.
	" 7	11 37 49.2	10 49 3.83	3	12 21 47.9	1	"
	" 8	11 54 16.3	10 44 26.13	6	12 28 32.7	3	"
	" 8	13 29 28.4	10 44 23.37	3	12 29 8.4	2	Besse-Bergier.
	" 9	13 32 34.4	10 43 44.57	4	12 39 49.9	2	Lépissier.
Cambridge	" 18	12 51 56.2	10 37 27.50	10	13 37 57.8	10	Challis.
	" 19	12 37 41.9	10 36 43.29	10	13 41 54.0	10	"
	" 20	12 33 1.9	10 35 59.04	10	13 51 45.6	10	"
	" 22	12 23 40.1	10 34 29.18	10	14 5 30.1	10	"
Marseilles	April 1	8 11	10 12 9.8		17 2 12		Valz.
	" 2	10 11	10 11 54.0		17 3 6		"
	" 6	8 18	10 11 5.9		17 9 20		"
	" 8	9 45	10 10 48.8		+ 17 11 30		"

DR. FÖRSTER has given, in the *Astr. Nachr.* N° 1136, the following elements of *Nemausa*, deduced from observations at Marseilles Feb. 3, and Berlin Mar. 2, 19, 28. (He estimated the planet in March as of the 9½ magnitude.)

Epoch = 1858 Mar. 2.59128 Berlin M.T.

$$\begin{aligned}
 M &= 312^{\circ} 31' 21.8 \\
 \pi &= 190 \ 12 \ 31.7 \\
 Q &= 175 \ 37 \ 35.6 \\
 i &= 10 \ 14 \ 39.4 \\
 q &= 3 \ 36 \ 13.0 \\
 \log a &= 0.376196 \\
 \mu &= 967.638
 \end{aligned}
 \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} 1858.0$$

FIFTY-THIRD ASTEROID.

OF this planet, discovered April 4 by Dr. LUTHER in Bilk, and named *Calypso*. Mr. LEVERRIER has communicated the following observations, and the ephemeris by Mr. OELTZEN of Vienna :

Place.	Date.	M.T. of Place.	α	δ	No. Comp.	Observer.
Bilk	1858 April 4	^h ^m ^s 12 32 13	^h ^m ^s 12 4 13.11	[°] ['] ["] + 5 30 31.2	10	Luther.
Bonn	" 6	11 54 38	12 2 45.29	5 41 23.5	7	Schönfeld.
Hamburg	" 8	10 37 15	12 1 24.21	5 51 6.6		G. Rümker.
Berlin	" 9	10 27 56.2	12 0 42.60	5 56 16.4		Bruhns.
Bonn	" 9	12 16 0	12 0 39.26	+ 5 56 40.7		Schönfeld.

EPIHEMERIS OF *CALYPSO*.1858 *Berlin Mean Noon.*

	α	δ		α	δ		α	δ
April 28	11 ^h 51 ^m 43 ^s	+6° 53'	May 6	11 ^h 50 ^m 22 ^s	+6° 59'	May 14	11 ^h 50 ^m 10 ^s	+6° 55'
29	51 29	6 54	7	50 17	6 59	15	50 15	6 53
30	51 16	6 56	8	50 12	6 59	16	50 20	6 52
May 1	51 5	6 57	9	50 9	6 59	17	50 27	6 50
2	50 51	6 57	10	50 6	6 58	18	50 34	6 49
3	50 45	6 57	11	50 5	6 58	19	50 43	6 47
4	50 36	6 58	12	50 4	6 57	20	11 50 52	+6 45
5	11 50 29	+5 59	13	11 50 7	+6 56			

ELEMENTS AND EPHEMERIS OF *NEMAUSA*.

BY JAMES C. WATSON.

THE following elements of *Nemausa* have been computed from the observations at Marseilles February 15, Bilk March 5, and Vienna March 18 :

Epoch = 1858 March 18.5 Washington M.T.

 $M = 352^{\circ} 25' 53.0$ $\pi = 183^{\circ} 57' 6.9$ $\Omega = 175^{\circ} 37' 42.6$ $i = 10^{\circ} 9' 54.7$ $q = 3.3410.5$ $\log a = 0.375184$ $\log \mu = 2.987231$ $\mu = 971''.026$ *Ephemeris for Washington Mean Midnight.*

1858	α	δ	$\log \Delta$	$\log r$	1858	α	δ	$\log \Delta$	$\log r$
April 24	11 ^h 16 ^m 46 ^s	+7° 57.7'	0.15232	0.34730	May 15	11 ^h 22 ^m 52 ^s	+8° 32.0'		
25	16 46	8 1.7			16	23 26	31.1	0.21411	
26	16 48	5.5	0.15765		17	24 2	30.0		
27	16 53	9.0			18	24 39	28.7	0.21986	0.34766
28	16 59	12.3	0.16306	0.34733	19	25 18	27.2		
29	17 6	15.3			20	25 58	25.5	0.22558	
30	17 16	18.1	0.16856		21	26 39	23.6		
May 1	17 27	20.7			22	27 22	21.6	0.23131	0.34776
2	17 40	23.0	0.17111	0.34737	23	28 6	19.4		
3	17 55	25.1			24	28 51	17.0	0.23698	
4	18 11	26.9	0.17973		25	29 37	14.4		
5	18 29	28.5			26	30 25	11.6	0.24266	0.34787
6	18 48	29.9	0.18539	0.34742	27	31 14	8.7		
7	19 9	31.1			28	32 4	5.6	0.24877	
8	19 31	32.0	0.19110		29	32 55	8 2.3		
9	19 55	32.6			30	33 47	7 58.8	0.25389	0.34800
10	20 21	33.0	0.19683	0.34749	31	34 40	55.2		
11	20 48	33.2			June 1	35 34	51.4	0.25943	
12	21 17	33.2	0.20258		2	36 30	47.5		
13	21 47	33.0			3	37 27	43.4	0.26498	0.34813
14	11 22 19	+8 32.6	0.20834	0.34757	4	11 38 25	+7 39.2		

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FIFTY-THIRD ASTEROID.

ELEMENTS AND EPHEMERIS OF *NEMAUSA* : BY MR. JAMES C. WATSON.

ALBANY : C. VAN BENTHUYSEN, PRINTER.

THE ASTRONOMICAL JOURNAL. No. 114.

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ALBANY, 1858, JUNE 22.

NO. 18.

NOTE ON THE RED-HILL CATALOGUE OF CIRCUMPOLAR STARS,

BY PROFESSOR PEIRCE.

MR. CARRINGTON'S comparison of his observations with those of SCHWERT exhibits a singular anomaly, which is probably due to some inconsistency between the methods of observation, and which requires a careful discussion of these methods, before the observations can be used for the determination of the secular motions of the stars. MR. CARRINGTON'S polar distances are, upon an average, three-fourths of a second less than those of SCHWERT. This diminution of polar distance is not restricted to the stars in any especial locality; although it is rather larger for the stars which are more remote from the pole, and for those stars which are between 12^h and 18^h of right ascension. MR. CARRINGTON'S right-ascensions are also greater than those of SCHWERT; and the difference is so

great, that when multiplied by the cosine of the declination, it is, on the average, more than a second of arc. In the following tables, the average excesses of CARRINGTON'S polar distances, and the product of the excesses of right ascension by the cosine of declination, above those of SCHWERT, are given for each octant of right-ascension; and for the polar distances, first from 0° to 3° , second from 3° to 5° , third from 5° to 7° , and lastly from 7° to 9° . The mean angles are also given, which the direction of CARRINGTON'S from SCHWERT'S place makes with the arc of the meridian directed toward the north; and also the average distances of the two places from one another in arc.

COMPARISON OF CARRINGTON'S AND SCHWERT'S CATALOGUES OF CIRCUMPOLAR STARS.

Octant of a	Number of Observations.				Mean excess of CARRINGTON'S Polar distance				Mean Excess of CARRINGTON'S $a \cdot \cos \delta$			
	0° to 3°	3° to 5°	5° to 7°	7° to 9°	0° to 3°	3° to 5°	5° to 7°	7° to 9°	0° to 3°	3° to 5°	5° to 7°	7° to 9°
1	13	18	20	26	+ 0.31	— 0.67	0.45	— 0.68	+ 1.20	+ 0.77	— 0.09	+ 1.21
2	2	18	24	26	+ 1.30	— 0.88	0.66	0.35	+ 0.50	1.46	+ 2.14	1.48
3	7	14	20	29	— 0.06	+ 0.31	1.13	0.42	— 0.01	0.03	0.99	0.78
4	11	21	24	28	0.54	— 0.35	0.98	0.53	— 0.12	1.00	1.09	1.66
5	14	16	23	31	0.06	1.52	1.30	2.04	+ 0.49	0.22	1.44	1.53
6	7	16	32	43	1.54	1.09	1.34	1.59	0.00	0.78	1.45	2.00
7	12	14	35	40	1.08	1.01	0.53	0.45	+ 1.07	0.84	0.94	1.23
8	3	17	22	43	— 0.97	— 0.51	— 0.73	— 0.37	+ 1.33	+ 1.67	+ 1.32	+ 0.74

Octant of a	Dist. of CARRINGTON'S place from SCHWERT'S.				Angle of direction of CARRINGTON'S place from SCHWERT'S (counted from north).			
	0° to 3°	3° to 5°	5° to 7°	7° to 9°	0° to 3°	3° to 5°	5° to 7°	7° to 9°
1	"	"	"	"	$^\circ$	$^\circ$	$^\circ$	$^\circ$
2	1.24	1.02	0.45	1.39	104.3	49.2	318.3	60.7
3	1.39	1.70	2.24	1.52	159.1	59.0	72.8	76.7
4	0.06	0.30	1.50	0.89	352.5	175.3	41.3	61.5
5	0.56	1.06	1.46	1.74	347.9	70.5	48.2	71.3
6	0.49	1.54	1.93	2.55	83.3	8.3	47.9	36.9
7	1.54	1.34	1.97	2.56	359.9	35.6	47.1	51.6
8	1.51	1.31	1.08	1.31	44.4	39.5	60.5	69.6
8	1.64	1.75	1.51	0.83	53.9	73.2	61.2	63.5

ELLIPTIC ELEMENTS OF COMET 1858 I.

BY ASAPH HALL,

STUDENT IN ASTRONOMY, HARVARD COLLEGE OBSERVATORY.

[Communicated by W. C. BOND, Esq.]

Epoch = 1858 Jan. 4.58985 Greenwich M. T.

$$\begin{array}{rcl}
 M & = & 356^{\circ} 24' 54.29 \\
 \pi & = & 115 \ 47 \ 53.39 \\
 \Omega & = & 269 \ 3 \ 17.54 \\
 i & = & 54 \ 24 \ 25.16 \\
 q & = & 55 \ 10 \ 52.00 \\
 \log a & = & 0.7580735 \\
 \log \mu & = & 2.4128963
 \end{array}
 \left. \vphantom{\begin{array}{rcl} M \\ \pi \\ \Omega \\ i \\ q \\ \log a \\ \log \mu \end{array}} \right\} \text{Mean Eq. 1858.0}$$

Periodic Time = 13.71256 years.

These elements have been computed from the Cambridge observations of

1858		$\angle \alpha$	$\angle \delta$
Jan. 4	9 ^h 31 ^m 55.8	23 ^h 42 ^m 30.30	+39° 44' 9.1
Feb. 6	6 43 2.7	1 58 31.71	+ 5 53 7.5
Mar. 12	7 23 16.8	3 42 15.41	-20 33 38.5

A comparison with the middle place gives

$$d\lambda = +3.96 \quad \text{C.} - 0. \quad d\beta = -4.82$$

FROM A LETTER OF PROFESSOR ARGELANDER TO THE EDITOR.

Bonn, 1858 April 12.

I HOPE that my letters of March 13 and 16 are already in your hands, and that you also have succeeded in finding the comet. For greater security, I inclose you now the elements and ephemeris which Dr. WINNECKE has computed from the present opposition alone, namely, from the observations of March 8 & 18 and April 6 at Bonn, and March 28 at Berlin.

Epoch = 1858 May 2.52779 Berlin M. T.

$$\begin{array}{rcl}
 M & = & 0^{\circ} \ 0' \ 0.0 \\
 \pi & = & 162 \ 59 \ 59.85 \\
 \Omega & = & 113 \ 0 \ 36.25 \\
 i & = & 10 \ 42 \ 43.4 \\
 q & = & 47 \ 35 \ 5.2 \\
 \log a & = & 0.466646 \\
 \log \mu & = & 2.8550037
 \end{array}
 \left. \vphantom{\begin{array}{rcl} M \\ \pi \\ \Omega \\ i \\ q \\ \log a \\ \log \mu \end{array}} \right\} \text{Equinox 1858.0}$$

According to this, the comet has completed eight revolutions since 1819.

From these elements, Dr. WINNECKE has computed the following little ephemeris for 0^h Berlin M. T.

1858	$\angle \alpha$	$\angle \delta$	$\log r$	$\log \Delta$
April 26	345° 23.9	-0° 22.6	9.8889	9.8794
27	346 47.0	0 16.4		
28	348 3.9	0 10.0		
29	349 19.7	-0 3.4		
30	350 34.8	+0 3.6	9.8852	9.9057
May 1	351 43.3	0 10.6		
2	353 0.7	0 17.8		
3	354 12.2	0 25.2		
4	355 22.5	0 32.8	9.8847	9.9313
5	356 31.9	0 40.6		
6	357 40.5	0 48.5		
7	358 48.1	+0 56.6		

1858	$\angle \alpha$	$\angle \delta$	$\log r$	$\log \Delta$
May 8	359° 54.8	+1° 4.8	9.8876	9.9558
9	1 0.5	1 13.1		
10	2 5.4	1 21.6		
11	3 9.4	1 30.1		
12	4 12.6	1 38.8	9.8937	9.4791
16	8 17.3	2 14.3	9.9027	0.0009
20	12 9.9	2 50.5	9.9140	0.0211
24	15 51.2	3 26.9	9.9274	0.0399
28	19 21.7	4 2.9	9.9422	0.0568
June 1	22 41.8	4 37.9	9.9582	0.0718
5	25 51.6	+5 11.4	9.9750	0.0856

I add the observations which we have made up to date, all by the discoverer himself:

1858	Bonn M.T.	$\angle \alpha$	$\angle \delta$
March 8	16 ^h 16 ^m 52 ^s	258° 56' 24.8	-1° 54' 7.3
"	16 54 57	258 58 47.8	1 54 14.6
11	16 2 35	214 14 14.9	1 58 39.8
"	16 28 21	264 16 13.0	1 58 36.6
12	15 45 8	266 3 16.3	1 59 58.4
18	15 22 55	277 36 40.8	2 5 15.0
"	15 48 48	277 38 49.0	2 5 13.4
20	15 47 56	281 40 30.6	2 5 43.5
21	14 56 59	283 37 41.3	2 6 2.6
22	15 26 20	235 42 37.5	2 5 45.0
23	16 14 32	287 49 25.9	2 5 32.4
April 6	15 27 43	315 21 52.0	-1 45 36.8

Also an observation by FORSTER:

	Berlin M. T.	$\angle \alpha$	$\angle \delta$
1858 Mar. 28	15 ^h 42 ^m 25 ^s	297° 55' 45.3	-2° 2' 9.4

FR. ARGELANDER.

ELEMENTS AND EPHEMERIS OF CALYPSO.

BY JAMES C. WATSON.

THE following elements of *Calypso* have been computed from the observations at Bilk April 4, and at Berlin April 9 & 13 :

Epoch = 1858 April 13.5 Washington M.T.
 $M = 50^{\circ} 57' 24.1$
 $\pi = 82 \ 56 \ 47.8$
 $Q = 148 \ 58 \ 52.5$ } Mean Equinox 1858.0
 $i = 5 \ 49 \ 20.8$
 $q = 27 \ 3 \ 31.4$
 $\log a = 0.472982$
 $\log \mu = 2.840534$
 $\mu = 692.682$

These elements give the following

Ephemeris for Washington Mean Midnight.

1858	α	δ	$\log \Delta$	$\log r$	1858	α	δ	$\log \Delta$	$\log r$
	^h ^m ^s	[°] [']				^h ^m ^s	[°] [']		
May 12	11 50 39	+ 6 50.8	0.32453	0.44592	May 31	11 55 42	+ 6 1.4	0.38551	
13	11 50 44	6 49.4	0.32778		June 1	11 56 9	5 57.6	0.38866	0.46039
14	11 50 51	6 47.8	0.33104	0.44740	2	11 56 37	5 53.7	0.39173	
15	11 50 59	6 46.1	0.33430		3	11 57 5	5 49.7	0.39481	0.46178
16	11 51 8	6 44.3	0.33756	0.44887	4	11 57 35	5 45.6	0.39791	
17	11 51 18	6 42.3	0.34078		5	11 58 5	5 41.4	0.40101	0.46317
18	11 51 30	6 40.2	0.34403	0.45035	6	11 58 37	5 37.2	0.40403	
19	11 51 43	6 38.0	0.34727		7	11 59 9	5 32.8	0.40705	0.46455
20	11 51 57	6 35.6	0.35052	0.45181	8	11 59 42	5 28.4	0.41009	
21	11 52 12	6 33.1	0.35373		9	12 0 16	5 23.8	0.41314	0.46593
22	11 52 28	6 30.4	0.35694	0.45326	10	12 0 51	5 19.1	0.41610	
23	11 52 45	6 27.7	0.36016		11	12 1 26	5 14.4	0.41906	0.46729
24	11 53 4	6 24.8	0.36338	0.45471	12	12 2 3	5 9.6	0.42205	
25	11 53 23	6 21.8	0.36655		13	12 2 40	5 4.7	0.42504	0.46866
26	11 53 44	6 18.7	0.36972	0.45613	14	12 3 18	4 59.7	0.42792	
27	11 54 5	6 15.5	0.37291		15	12 3 57	4 54.7	0.43081	0.47000
28	11 54 28	6 12.1	0.37610	0.45756	16	12 4 36	4 49.5	0.43373	
29	11 54 52	6 8.7	0.37923		17	12 5 16	4 44.3	0.43666	0.47135
30	11 55 17	+ 6 5.1	0.38236	0.45897	18	12 5 57	+ 4 39.0	0.43954	

FROM A LETTER OF MR. WATSON TO THE EDITOR.

Ann-Arbor, 1858 May 10.

IN the early part of last week I sent you elements and an ephemeris of *Nemausa*, which you have probably received. I have since that time observed the planet as follows :

1858	Ann-Arbor M.T.	α	δ	No.Comp.
May 6	10 ^h 29 ^m 51. ^s 5	11 ^h 19 ^m 7. ^s 15	+8° 26' 11".8	10
7	11 23 54.7	11 19 29.32	8 27 17.1	10
8	11 18 31.2	11 19 52.36	8 28 4.3	5
9	12 43 18.6	11 20 18.41	+8 28 48.0	5

Mean Place 1858.0 of Comparison-Star.

*	Mag.	α	δ	Authority.
Bessel's Z. 237, 23	9.0	11 ^h 20 ^m 12. ^s 46	+8° 25' 0".8	Bessel's Zones.

The planet is estimated at the 10.11 magnitude.

In the observations of *Nemausa* at Marseilles Jan. 22 and 24, the planet is said to have been 15' and 18' respectively south from the star of comparison ; whereas, in obtaining the resulting place of the planet, Professor VALZ has evidently applied the difference in δ with a wrong sign, as if it were north from the star ; and the places of the planet as given in the *Astr. Nachrichten* N^o 1126 and in the *Astr. Journal* N^o 111, are, therefore, 30' in error in the declination. This discrepancy readily explains why the elements deduced by Professor VALZ from the Marseilles observations differ so much from their true values. JAMES C. WATSON.

FROM A LETTER OF PROFESSOR WINLOCK TO THE EDITOR.

Office American Ephemeris, Cambridge, 1858 March 31.

A FEW days ago Professor CASWELL of Providence communicated to Mr. RUNKLE of this office his observation of the end of the solar eclipse of March 15, which he found to be 7^h 41^m 28^s.7 Providence M.T., with a probable error of 3^s. The time, as computed by Mr. NEWCOMB from the Tables of

Data in the American Ephemeris and Nautical Almanac, was 7^h 41^m 28^s.5.

The close agreement is undoubtedly accidental : still it shows that our Lunar Ephemeris is probably within the limits of errors of observation.

JOSEPH WINLOCK.

OBSERVATION OF ALGOL-MINIMUM.

MADE AT WELD, FRANKLIN COUNTY, MAINE.

BY STILLMAN MASTERMAN.

1858 MARCH 28.

Very clear, and moonlight bright.

Watch Time.	COMPARISON.		
	δ	ρ	*
7 ^h 44 ^m	$\beta \frac{1}{2} \delta$	$\beta 2\frac{1}{2} \rho$	$\beta 1 \frac{1}{2} *$
50	=	$2\frac{1}{2}$	$\frac{1}{2}$
56	=	$2\frac{1}{2}$	=
8 2	$\delta 1 \beta$	2	=
8	$1\frac{1}{2}$	$1\frac{1}{2}$	* $\frac{1}{2} \beta$
14	2	$1\frac{1}{2}$	1
20	2	$1\frac{1}{2}$	1
26	2	1	1
32	2	1	$1\frac{1}{2}$
38	$2\frac{1}{2}$	$\frac{1}{2}$	2
44	$2\frac{1}{2}$	$\frac{1}{2}$	2
50	$2\frac{1}{2}$	$\frac{1}{2}$	2
56	$2\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{2}$
9 2	$2\frac{1}{2}$	1	$1\frac{1}{2}$
8	2	1	$1\frac{1}{2}$
14	$1\frac{1}{2}$	$1\frac{1}{2}$	1
20	$1\frac{1}{2}$	$1\frac{1}{2}$	1
26	1	$\beta 2 \rho$	=
9 32	$\delta 1 \beta$		* = β

*Observed Time of Minimum.*By comparison with δ :

$$\left. \begin{array}{l} 8^h 45^m 50 \\ 8 \ 50.00 \end{array} \right\} \begin{array}{l} 8^h 47^m 75 \\ (Weight \ 2). \end{array}$$

With ρ :

$$\left. \begin{array}{l} 8^h 45^m 50 \\ 47.00 \\ 8 \ 47.00 \end{array} \right\} \begin{array}{l} 8^h 46^m 50 \\ (Weight \ 4). \end{array}$$

With * :

$$\left. \begin{array}{l} 8^h 48^m 50 \\ 47.00 \\ 8 \ 44.00 \end{array} \right\} \begin{array}{l} 8^h 46^m 50 \\ (Weight \ 1). \end{array}$$

Final mean 8^h 46^m 86

Correction for watch-error . . . + 0.84

8 47.70

Longitude east from Washington . . . 26.65

Observed minimum, March 28 . . . 8 21.05 Wash. M.T.

FROM A LETTER OF DR. BRUHNS TO THE EDITOR.

Berlin, 1858 May 22.

TO-DAY I write to inform you of my detection of a new comet, —although this stranger may very probably have been already seen in your country at an earlier date.

I found it this morning in *Andromeda*, and observed it :

1858 Berlin M.T. $\beta \alpha$ $\beta \delta$
May 21 11^h 21^m 54^s.8 24° 3' 25".4 +39° 57' 52".8 ;

the comparison-star having been Lalande N^o 3023,24, the mean place of which for 1858.0 I assume to be

$$\begin{array}{cc} * \alpha & * \delta \\ 22^{\circ} 55' 52".2 & +39^{\circ} 57' 47".1 \end{array}$$

The daily motion amounts to +138' in right-ascension and to +80' in declination. The diameter is about 3 or 4, and the comet easily observed. I hope soon to send you the results of some of my observations of the interesting periodical comet 1858 I.

CARL BRUHNS.

SUPPOSED VARIABLE STAR.

MR. LE VERRIER announces the detection by Mr. GOLDSCHMIDT of a star, which all reasonable probability indicates as variable. Its approximate mean position for 1800 is

$$\alpha = 13^h 17^m 30^s; \quad \delta = -2^\circ 9'$$

In April and May 1857, this star was of the 7th magnitude: after some weeks it had perceptibly diminished, and in April last was invisible.

This star is at present (June 19) certainly below the 11th magnitude. G.

ELEMENTS AND EPHEMERIS OF THE THIRD COMET OF 1858.

BY JAMES C. WATSON.

THE elements have been computed from the observations at Cambridge (Mass.) May 3, 4 and 12, and the two following positions:

1858	Ann-Arbor M.T.	α	δ	Comp.
May 9	11 ^h 2 ^m 51.2	10 ^h 23 ^m 37.46	+37° 4' 47.4	10
12	11 19 55.0	10 40 0.69	+37 45 29.9	10

They are the following:

$$\begin{aligned} T &= 1858 \text{ May } 2.107254 \text{ Washington M.T.} \\ \pi &= 195^\circ 58' 44.3 \\ \Omega &= 170^\circ 42' 56.4 \\ i &= 22^\circ 59' 48.6 \\ \log q &= 0.082676 \end{aligned} \quad \left. \begin{array}{l} \\ \\ \\ \end{array} \right\} \text{Mean Equinox 1858.0}$$

Motion Direct.

The comparison of the middle place gives the following residual error:

$$\Delta\alpha = 0.0 \quad \Delta\delta = +0.2$$

These elements give the following

Ephemeris for Washington Mean Midnight.

1858	α	δ	$\log \Delta$
May 27	12 ^h 2 ^m 35	+38° 4.6	9.83154
28	12 7 52	37 55.6	9.83488
29	12 13 6	37 45.6	9.83818
30	12 18 16	37 34.5	9.84160
31	12 23 22	37 22.4	9.84508
June 1	12 28 25	37 9.2	9.84862
2	12 33 24	36 55.1	9.85222
3	12 38 19	36 40.1	9.85589
4	12 43 10	36 24.1	9.85963
5	12 47 58	36 7.2	9.86342
6	12 52 52	35 49.5	9.86726
7	12 57 21	35 31.0	9.87116
8	13 1 56	35 11.7	9.87512
9	13 6 27	34 51.7	9.87913
10	13 10 54	34 31.1	9.88318
11	13 15 16	34 9.9	9.88728
12	13 19 33	33 48.0	9.89143
13	13 23 46	+32 25.6	9.89562

Ann-Arbor, 1858 May 31.

NEW WORKS.

1. ARGELANDER'S *Atlas des Nördlichen gestirnten Himmels für den Anfang des Jahres 1855.*

THE Second Part of this great work, already alluded to in N° 103 of the *Astronomical Journal*, was issued in February, having been somewhat delayed in the hands of the lithographer. Each Part consists of four charts; and the third Part, which is now speedily to follow, will complete the first Section,—this comprising the region south of 20° N. declination, the first two degrees of S. decl. being also included.

The projection of the twelve charts which constitute this section is rectangular, the area being divided into perfect squares, each including one degree of right-ascension and one of declination.

The second Section will extend from 19° to 41°, the third from 40° to 61°, the fourth from 60° to 80°, the fifth from 79° to the pole. In all these four Sections the parallels are equidistant concentric circles, and the meridians straight lines intersecting them perpendicularly as radii. For the first

three of them the centers for the declination-parallels are so taken that at one quarter's distance from the two boundaries the degrees of right-ascension bear the correct ratio to those of the meridian. The last Section consists of a single chart, the center representing the pole.

The stars are denoted upon these charts by points, or rather by circular dots, of which the diameters vary from less than $\frac{1}{100}$ to $\frac{1}{15}$ of an inch, according to the magnitude of the star. Only the first and second magnitudes are represented with rays; the former having eight, the latter four of them.

A detailed and interesting account of the processes employed by Prof. ARGELANDER for the preparation of these charts and their accompanying catalogue, for the avoidance of errors, the detection of those previously committed, the discovery of variable stars, &c., was given by Prof. ARGELANDER in a small work entitled "*Anzeige von einer unternommenen Durchmusterung des Nördlichen Himmels, als Grundlage neuer Himmelscharten*," which may be studied

with great benefit, and will form a priceless model for analogous investigations hereafter; although so far as the northern hemisphere is concerned, the field might be regarded for the present as exhausted.

The charts are given to the world with a beauty of execution and an evident amount of pains in their mechanical preparation, commensurate with the wonderful labor and the maturely conceived skilfulness of device which characterize the gigantic enterprise. May their illustrious author and his gifted and zealous assistants long enjoy the contemplation and correctness of the new impulse which they impart to the progress of Stellar Astronomy!

The charts may be obtained of

MESSRS. B. WESTERMANN & CO., *New-York*;

I. EGGERS & WILDE, *Cincinnati*;

E. SCHAFER & KORADI, *Philadelphia*.

2. *The Mathematical Monthly*. Under this title, Mr. RUNKLE of the Nautical Almanac Office proposes to publish a journal specially devoted to the diffusion of mathematical knowledge, and the publication of the results of mathematical research. A circular note was addressed by Mr. RUNKLE to a very large number of persons interested in mathematical investigation, asking their views concerning the usefulness of such a journal. The replies being unanimous in favor of its establishment and support, and coöperation being promised from many sources, the Prospectus has now been issued, and the first number will be issued as soon as the subscriptions shall be sufficient to cover the expense of publication.

Mr. RUNKLE's views may be best given in his own language:

"May not such a journal have a scope sufficiently comprehensive and elastic to embrace all grades of talent and attainment, and, therefore, corresponding elements of interest? If so, then it should embrace students in one extreme, and professed mathematicians in the other; which extremes necessarily include all intermediate grades of teachers and laborers in this vast field.

"The journal should contain, for all learners, clear and concise notes upon all points of theory and application in all branches of the science; and these notes should come from able contributors, who can be plain without being weak,—who can unite simplicity of treatment with elegance of style.

"It should contain 'all seraps of mathematical writing too good to be lost,' whether elementary or profound, whether original in manner or matter, whether complete in themselves or to be resumed at the convenience of the author, whether notices or reviews of matter old or new; in short, every thing fitly designated by 'notes and queries.' Besides, it should contain 'carefully elaborated essays, chiefly valuable perhaps as promises of better things hereafter,' as well as those of a higher character.

"There is another large field in which the Journal will

find its legitimate work,—one in which it can do the double duty of inducting students and younger mathematicians into the highest departments of the science, and of opening to the abler and more experienced an opportunity to contribute their share to the noble work of elevating the standard of mathematical learning in the country. All mathematicians know that there are many subjects in the higher departments of the science upon which little, if anything, has as yet been written among us. Now, if they will take these subjects and develop them fully and systematically through the pages of the Journal, they may afterwards be issued in a separate form from the stereotype plates, at a very small cost. In such cases the right and benefit thereof shall vest in the author.

"In this way we shall secure the coöperation of all: of students and younger mathematicians, for the range embraces them with their respective abilities and attainments, and therefore interests; of professed mathematicians, for, besides the large field specified above, neither their dignity nor scientific character can be affected by communicating notes which might not be of sufficient importance to warrant insertion in a journal of high scientific pretensions.

"In fine, then, the Journal will be to the professed mathematician a recreation and a study, while to the student it will be a study and example."

Each number of the *Mathematical Monthly* will contain at least twenty-four pages. The price of subscription is \$3.00 a year, payable in advance. To be published by JOHN BARTLETT, Cambridge, Mass.

3. *Schumacher's Scientific Correspondence*.

FOR nearly half a century, the distinguished and genial SCHUMACHER stood in active correspondence not only with almost all other astronomers and makers of astronomical instruments, but with many prominent scientists in other departments of research. This voluminous correspondence is still in existence, and naturally of extreme interest not only intrinsically, but from its relation to the history of science.

The heirs of Professor SCHUMACHER have confided to his eminent and worthy successor Professor PETERS the selection and arrangement of these letters for the press, and have decided to commence the publication as soon as sufficient encouragement shall be given.

The correspondence of SCHUMACHER with OLBERS and GAUSS will first be issued. Through the facilities afforded by the present representatives of these great names, the letters from SCHUMACHER have been placed at Professor PETERS's disposal, so that those two series are fully complete.

The letters between GAUSS and SCHUMACHER will be contained in three octavo volumes of about 450 pp. each, and those between OLBERS and SCHUMACHER in two similar volumes. The price has been fixed at three thalers (Prussian)

the volume, payable on delivery : and subscriptions will be received for each set separately.

Inquiries may be directly addressed to Professor PETERS in Altona.

4. *Catalogue of 3735 Circumpolar Stars, observed at Red-hill in the years 1854, 1855 & 1856, and reduced to mean positions for 1858.0 by R. C. CARRINGTON.* London, 1857.

THIS catalogue, together with its accompanying charts engraved on copper, are a contribution to astronomy from the private observatory of Mr. CARRINGTON : they have been deservedly printed at the public expense by order of the Lords Commissioners of the Admiralty, and distributed with great liberality.

The catalogue contains stars of magnitudes below the eleventh, within a circle of 9° polar distance : none observed less than three times, and with careful estimation of magnitude, which, thanks to the labors of ARGELANDER and other astronomers following in his footsteps, constitutes a distinguishing feature of recent astronomical progress. The observations were made and reduced in zones.

In a separate list are given the positions of 19 stars within 42' of the pole.

Beside the star-positions and the observations on which they depend, the catalogue contains a large amount of additional and valuable information, prominent among which are 1° the full comparison of the places with those of SCHWED, 2° a full detailed account of the processes employed in observing and reducing, and 3° an extended discussion of the reduction-formulas.

Mr. CARRINGTON may well be congratulated both upon the promptness with which he has brought his useful labor to a thorough and satisfactory completion, and on the valuable contribution to astronomy which by his individual efforts he has succeeded in making.

5. *Biographisch-literarisches Handwörterbuch zur Geschichte der exacten Wissenschaften, gesammelt von J. C. POGGENDORFF.* 1^{ste} Lieferung. Leipzig, 1858.

THIS first part of Professor POGGENDORFF's great biographical lexicon of the exact sciences has recently appeared. The entire work will be comprised in one volume, and issued in four parts ; and it contains, in brief abstract, biographical notices of mathematicians and persons actively engaged in the pursuit of the several physical sciences. The special contents of each notice are, the entire name, profession, date of birth and of death also, if not living, and a list of principal contributions to science.

Professor POGGENDORFF earnestly desires aid from every quarter, and will feel indebted to all who will contribute to increasing the completeness and accuracy of the work, by supplying him with additional information.

The price of the complete work will be about nine Prussian thalers.

6. *De Cometten van de Jaren 1556, 1264 en 1975, en hare vermeende Identiteit.* Academisch Proefschrift : Door MARTINUS HOEK. 'sGravenhage, 1857.

AN extended and thorough discussion of the Observations of the Comets of 975, 1264 and 1556, with reference to the question of their identity. The results have been already given in astronomical periodicals : Dr. HOEK and Mr. HIND differing, as is well known, as to the possibility or probability of identity. The discussion of the observations seems essentially exhausted by the investigations of HOEK.

7. *Eerste Onderzoekingen met den Mikrometer van AIRY, volbragt op het Observatorium der Hogeschool te Leiden : Door F. KAISER.* Amsterdam, 1857.

AN extended discussion, with characteristic thoroughness, of the history, construction, and advantages of the double-image micrometer, together with observations made by its use at the Leyden Observatory, especially upon planetary diameters, with full references to former measurements.

8. *Briefwechsel zwischen Herrn Staatsrath OTTO STRUVE, Astronom an der Sternwarte zu Pulkowa, und F. KAISER, Director der Sternwarte in Leiden, über die Aenderungen in den Dimensionen des Saturnrings, mitgetheilt von F. KAISER.*

9. *Populair Sterrekundig Jaarboek voor het Jaar 1858, door F. KAISER.* Amsterdam, 1857.

THE annual publication of its author, for the promotion and encouragement of astronomical tastes and pursuits in the Netherlands, in connection with his work *De Sterrenhimmel*. It contains ephemerides of six variable stars of short period.

10. *De Stelling van SECCHI te Rome omtrent den Ring van Saturnus, door F. KAISER.*

Two pamphlets with this title contain memoirs from the proceedings of the Royal Academy of the Netherlands, with discussions by Professor KAISER upon the dimensions of Saturn's ring, especially with reference to the recent controversy. The one contains investigations founded upon Professor KAISER's own observations ; the other, those founded upon SECCHI's.

11. *De Beweging der Aarde en hare jongst ontdekte bewijsgronden : Door F. KAISER, Hoogleraar te Leiden.*

A MEMOIR suggested by the pendulum experiments of FOUCAULT, and subsequently devised apparatus of analogous character.

12. *Inlichtingen omtrent de Groote Komeet, wier verschijning men thans verwacht : Door F. KAISER, Hoogleraar te Leiden.*

13. *Nadere Inlichtingen omtrent de Grootte Komeet*, &c. Two articles, containing a digest of our information concerning the return of the Comet 1556.

14. *Astronomical Observations made at the Royal Observatory, Edinburgh*, by CHARLES PIAZZI SMITH. Vol. XI, for 1849-54. Published by order of her Majesty's Government, 1857. pp. 290.

THIS volume contains observations with the Transit-instrument, with a resultant catalogue of mean right-ascensions for each of the six years over which the observations extend; and observations with the mural circle, followed by a catalogue of resultant polar distances, for the years 1852-54 inclusive.

These astronomical observations are followed by observations of the Earth-thermometers, during the years 1837-54 inclusive, together with explanatory remarks, and the monthly, quarterly and yearly means of the results.

To these are appended a Note on Solar Refraction; a Report upon the *Mare Crisium* and its shores, illustrated by three beautiful colored lithographs; and a paper, similarly illustrated, upon the total eclipse of the year 1851.

15. *Astronomical Observations made at the Observatory of Cambridge*, by the Rev. JAMES CHALLIS. Vol. XVIII. For the years 1849, 1850 & 1851.

IN this volume is contained a rich store of carefully measured positions of fixed stars, as well as of the Sun, Moon, Neptune and the asteroids.

Professor CHALLIS commenced in 1849 a series of observations of stars down to the 9th magnitude inclusive, contained within a zone of 5° on each side of the ecliptic; his working catalogue containing about 8000 stars.

All the Planetary observations are compared with theory.

CORRIGENDA IN VARIOUS WORKS.

1. In GAUSS'S *Theoria Motus*.

Professor CHAUVENET writes that the following important correction has been accidentally omitted from the list of those communicated by him, and published in N° 109 of this journal: Page 191, line 8,

$$\begin{aligned} \text{for } P &= \frac{R'' \sin \delta'' \sin \varepsilon}{R \sin \delta \sin \varepsilon''} = \frac{R \sin(l''-l)}{R \sin(l'-l)}, \\ \text{read } P &= \frac{R \sin \delta \sin \varepsilon''}{R'' \sin \delta'' \sin \varepsilon} = \frac{R \sin(l'-l)}{R'' \sin(l''-l)}. \end{aligned}$$

H. M. PARKHURST, Esq. sends also the following:

Page 102, line —1, for $f-g$ read $f+g$ (in denominator).

To these I would add:

Page 154, line 6, for AB' read AB .

These errors have passed into the translation also.

2. In the *Astronomical Journal*, Vol. V,

Page 93, line —14, for $0^h 12^m 84^s$ read $0^h 12^m 54^s$.

“ 111. For r Ceti read γ Ceti, twice.

“ 114. In SAFFORD'S elements of Comet 1858 I, insert $T = 1858$ Feb. 23.3195 Washington M.T.

“ 129, Col. 1. Aug. 18, for $15^h 8^m 58^s.6$ read $15^h 10^m 58^s.6$.

“ 132, Col. 6. Oct. 26, “ 23 35 25.57 “ 23 35 24.57.

3. In Shortrede's Logarithms, Table IV, logarithms to 16 places, 111 33, for 1343 read 1433.

[Communicated by Mr. PARKHURST.]

DUDLEY OBSERVATORY.

IN reply to numerous inquiries, I give the approximate position of this institution,—being in all probability trustworthy within the annexed limits of error.

Longitude = $0^h 13^m 12^s.6$ E. from Washington

Latitude = $+42^\circ 39' 50'' \pm 2''$

The telegraphic observations for longitude are now nearly closed, having been commenced the first of May. The constants of terrestrial magnetism have also been carefully determined; and the local values of the several physical con-

stants will be made known, as soon as the reductions and computations shall have been finished.

The preliminary adjustments for the great meridian-circle have advanced with a more than satisfactory rapidity,—the only serious delays having been occasioned by the time-consuming process of boring the massive piers for the microscopes and illuminating canals,—a work which was finally achieved with the most gratifying success. The clothing and casing for the piers are also completed, as well as the coarser adjustments for the instruments.

B. A. GOULD JR.

Albany, 1858 June 18.

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NEW WORKS.

CORRIGENDA IN VARIOUS WORKS.

DUDLEY OBSERVATORY.

THE ASTRONOMICAL JOURNAL. No. 115.

VOL. V.

ALBANY, 1858, JULY 30.

NO. 19.

LETTER FROM PROFESSOR BRÜNNOW TO THE EDITOR.

Ann-Arbor, 1858 June 22.

I HEREBY send you a few meridian-observations of asteroids, together with observations made with the new Equatorial of 12 $\frac{3}{8}$ English inches aperture, partly by Mr. WATSON, partly by him and myself.

My Meridian-observations are the following :

CALLIOPE.

1858.	Ann-Arbor M.T.			
Jan. 2	10 ^h 2 ^m 49.2	4 ^h 52 ^m 42.66	+ 29° 24'	18.1
9	9 30 37.0	4 48 0.93	29 38	56.4

THALIA.

April 5	12 ^h 36 ^m 28.4	13 ^h 33 ^m 26.82	+ 4° 48'	56.0
6	12 31 31.2	13 32 28.35	4 51	8.8

MASSALIA.

April 5	13 ^h 13 ^m 0.1	14 ^h 10 ^m 4.50	— 13° 7'	12.4
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HEBE.

May 6	12 ^h 28 ^m 42.1	15 ^h 27 ^m 52.31	+ 1° 40'	13.7
7	12 23 52.1	15 26 58.16	4 44	45.4
21	11 16 3.5	15 14 10.27	5 26	52.4

With regard to the observations made with the Equatorial, I will premise a few remarks.

The Telescope, which had been mounted before, but had not been accepted on account of its deficiencies, was taken down early in November. Though I expected to be able to mount the new Telescope immediately, it was found that some alterations were to be made, which delayed the mounting until the arrival of Mr. FITZ of New-York, the maker of the instrument, about the middle of December. Consequently no refractor-observation could be made here during that time. Since then, the weather has been very unfavorable ; so that the number of observations, especially during the months of Spring, is unusually small.

Until May, we had to use a micrometer very deficient in the illumination of the wires, so that the observation of faint objects was very difficult ; but since then we have used a new micrometer, in which this deficiency was remedied. The value of a revolution of the micrometer-screen was obtained from

many observations of *Polaris*, but I have not yet been able to determine the irregularities of the screw : the observations are therefore perhaps not as good, as I hope they will be in future.

The observation of Comet II, on April 6th, was made under unfavorable circumstances. The morning was exceedingly damp ; and when we commenced to observe the comet, the movable wire of the micrometer was found to be crooked. As all endeavors to straighten it failed, the declination of the comet was observed near the edge of the field, and the coincidence of the wires determined for the same point.

Though it is not my intention that the observation of comets and asteroids shall be the main object for which the large Refractor will be used, yet we will observe all comets, and besides the eight asteroids which we have selected, at least some of the newly discovered ones, and all those which are too faint for smaller instruments, or which are unfavorable for European observatories on account of their southern declination. Thus we have tried to observe *Atalanta*, but we have been very unlucky with it. On May 7th the planet was not found, perhaps on account of a mistake in the selected comparison-star ; and afterwards the southern horizon was never clear enough to admit of the observation of so faint an object. It was only on May 20th that I succeeded in finding the planet ; but as it became hazy immediately afterwards, Mr. WATSON could get only three comparisons of it. However I should think that the observation deserves some confidence ; and if so, the error of Dr. FÖRSTER's Ephemeris is very small.

To the kindness of G. P. BOND, Esq., I owe the communication of observations of the occultation of the *Pleiades* on March 19, which at last has enabled me to determine our longitude. I find for it

26^m 41^s.0 W. from Washington,

which will come very near the truth.

F. BRÜNNOW.

OBSERVATIONS OF THE COMETS 1858 I, 1858 II AND 1858 III, AND ASTEROIDS
EUROPA, NEMAUSA AND ATALANTA.

MADE AT ANN-ARBOR, MICHIGAN, WITH THE FILAR-MICROMETER OF THE EQUATORIAL.

BY JAMES C. WATSON.

[Communicated by Professor BRUNOW.—Corrected for refraction.]

FIRST COMET OF 1858.

Date.	Ann-Arbor M. T.	No. Comp.	Comparison-Star.	— *		/'s apparent	
				α	δ	α	δ
1858 Jan. 19	h m s	6	* 1	— 1 36.80	+ 0 36.8	h m s	° ' "
20	6 55 33.2	5	Bessel's Z. 445,33	+ 1 59.18	+ 1 45.6	0 49 23.17	+ 24 39 32.2
20	8 53 17.9	10*	" 445,33	+ 2 19.28	— 3 34.4	0 52 50.42	23 47 9.0
21	7 30 17.1	12*	* 2	— 1 39.53	— 0 29.7	0 53 10.22	23 41 49.0
22	8 51 25.6	10	Bessel's Z. 392,75	— 2 29.91	— 2 21.8	0 57 6.19	22 40 52.9
29	7 19 33.5	2	* 3	— 2 11.10	+ 0 26.1	1 1 29.14	21 33 41.2
29	7 19 33.5	2	* 4	— 2 44.10	+ 3 57.5	1 29 8.69	14 5 26.2
30	7 12 20.6	16*	Bessel's Z. 126,8	— 0 31.47	— 1 21.7	1 29 8.88	14 5 29.8
31	7 13 53.0	20*	* 5	+ 0 4.75	+ 3 11.8	1 32 57.69	13 2 0.4
Feb. 3	7 23 34.0	7	* 6	+ 1 2.80	+ 1 22.4	1 36 45.97	11 58 47.8
5	10 41 2.6	3	Lalande 3899	+ 4 0.40	+ 3 30.3	1 47 56.27	8 51 19.1
12	9 18 22.6	6*	* 7	+ 0 23.98	+ 1 57.3	1 55 40.20	+ 6 40 58.8
24	7 52 52.7	9*	* 8	— 1 0.71	— 2 12.4	2 57 7.87	— 10 1 36.0
26	8 5 34.8	5*	Bessel's Z. 206,109	+ 5 16.32	— 2 50.8	3 3 2.75	11 31 3.2
Mar. 5	7 43 19.3	9	Argelander's Z. 341,26	— 0 56.52	+ 0 30.3	3 23 1.18	16 20 5.1
9	7 37 4.0	12	" 329,1	— 0 23.12	+ 1 43.9	3 31 7.04	18 49 45.9
11	7 47 53.1	10*	* 9	+ 0 48.97	— 0 37.9	3 39 38.53	20 0 41.6
12	7 55 9.6	4	Argelander's Z. 320,59	— 3 51.92	— 2 37.2	3 42 21.33	20 35 47.9
18	7 33 17.7	10*	" 332,56	— 1 5.38	— 0 28.7	3 58 46.09	23 50 53.0
19	7 37 19.1	8*	" 332,62	— 1 40.75	+ 0 31.2	4 1 30.53	— 24 21 24.8

Adopted Mean Places 1858.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
Bessel's Z. 445,37	9	h m s	° ' "	Bessel's Zones.
* 1	8.9	0 52 45.63	+ 24 41 10.9	Equat. from B. Z. 445,37.
Bessel's Z. 445,33	7.8	0 51 0.39	24 38 46.5	Bessel's Zones.
* 2	9	0 50 51.17	23 45 15.0	Equat. from B. Z. 392,73.
Bessel's Z. 392,73	8.9	0 58 45.87	22 41 14.1	Bessel's Zones.
" 392,75	9	1 3 4.05	22 42 32.6	"
* 3	9	1 3 59.19	21 34 54.9	Equat. from B. Z. 32,35.
* 4	9	1 31 19.84	14 1 22.9	"
Bessel's Z. 32,35	6	1 31 53.33	14 4 57.9	Bessel's Zones.
" 126,8	8	1 28 11.20	13 56 5.3	"
* 5	9.0	1 33 29.19	13 3 16.6	Equat. from B. Z. 126,24.
Bessel's Z. 126,24	8	1 36 41.21	11 55 30.7	Bessel's Zones.
* 6	8.9	1 45 51.94	11 58 54.6	Equat. from B. Z. 111,33.
Bessel's Z. 111,33	9	1 46 53.36	8 49 52.3	Bessel's Zones.
Lalande 3899	9	1 45 8.11	8 53 1.2	Lalande's Catalogue.
* 8	9.0	1 59 40.47	+ 6 37 24.3	Equat. from B. Z. 204,83.
Bessel's Z. 204,83	8.9	2 58 8.31	— 9 59 23.1	Bessel's Zones.
" 206,109	9	2 52 43.76	9 59 10.3	"
Argelander's Z. 341,26	9	2 57 46.11	11 28 11.6	Argelander's Zones.
" 329,1	9	3 23 57.38	16 20 33.6	"
* 9	11	3 31 29.81	18 51 27.1	Equat. from Arg. Z. 320,44.
Argelander's Z. 320,44	6.7	3 38 49.26	20 0 1.2	Argelander's Zones.
" 320,59	8.9	3 35 1.81	20 2 33.7	"
" 332,56	9	3 46 15.96	20 33 8.1	"
" 332,62	8	3 59 51.24	23 50 21.3	"
		4 3 11.06	— 24 21 52.9	"

SECOND COMET OF 1858.

Date.	Ann-Arbor M.T.	No. Comp.	Comparison-Star.	— *		Comet's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 April 4	^h 15 ^m 34 ^s 1.1	10*	Bessel's Z. 16,28	^m + 0 ^s 11.91	['] + 5 ["] 4.1	^h 20 ^m 48 ^s 33.24	[°] — 1 ['] 49 ["] 52.4
5	16 17 33.0	10*	" 16,35	+ 0 25.31	+ 4 48.4	20 56 13.25	1 47 20.1
6	16 11 14.7	6*	" 16,45	— 2 18.57	— 2 2.3	21 3 30.85	— 1 41 52.1

Adopted Mean Places 1858.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
Bessel's Z. 16,28	7	^h 20 ^m 47 ^s 47.82	[°] — 1 ['] 54 ["] 46.9	Bessel's Zones.
" 16,35	8	20 55 47.47	1 51 59.1	"
" 16,45	8.9	21 5 48.98	— 1 42 40.9	"

THIRD COMET OF 1858.

Date.	Ann-Arbor M.T.	No. Comp.	Comparison-Star.	— *		Comet's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 May 9	^h 11 ^m 2 ^s 51.2	10*	Bessel's Z. 407,102	^m + 1 ^s 11.08	['] + 1 ["] 32.6	^h 10 ^m 23 ^s 37.46	[°] + 37 ['] 4 ["] 47.4
12	11 19 55.0	10*	* 1	+ 0 13.76	+ 5 31.9	10 40 0.69	37 45 29.9
18	13 23 47.5	1	* 2	— 2 36.40	+ 0 27.9	11 13 53.30	38 30 25.2
31	11 17 33.0	7*	* 3	+ 0 27.66	— 1 14.5	12 24 7.54	37 24 34.0
June 1	10 28 58.1	12*	Bessel's Z. 463,34	+ 0 47.07	— 0 31.4	12 29 3.90	+ 37 11 59.8

The comet was exceedingly faint, and was observed with some difficulty.

Adopted Mean Places 1858.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
Bessel's Z. 407,102	7	^h 10 ^m 22 ^s 24.12	[°] + 37 ['] 0 ["] 11.5	Bessel's Zones.
* 1	10	10 39 41.56	37 39 52.9	Equat. from B. Z. 411,8.
Bessel's Z. 411,8	8	10 46 46.21	37 30 59.5	Bessel's Zones.
* 2	8	11 16 27.23	38 29 56.2	Equat. from B. Z. 411,45.
Bessel's Z. 411,45	7.8	11 18 59.53	38 30 22.1	Bessel's Zones.
* 3	9.0	12 23 37.29	37 25 50.3	Equat. from B. Z. 463,30.
Bessel's Z. 463,30	9	12 26 0.79	37 20 57.7	Bessel's Zones.
" 463,34	8	12 28 14.25	+ 37 12 33.0	"

In the above observations of comets, those in which a * is placed after the number of comparisons (column 2) were made jointly by Professor BREXNOW and myself. The observation on Jan. 19, and the first one on Jan. 20, were taken with the ring-micrometer.

J. C. W.

EUROPA.

Date.	Ann-Arbor M.T.	No. Comp.	Comparison-Star.	Planet — Star		Apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 April 4	^h 10 ^m 47 ^s 28.9	4	Bessel's Z. 456,13	^m — 3 ^s 8.40	['] — 3 ["] 7.3	^h 10 ^m 11 ^s 23.97	[°] + 17 ['] 7 ["] 50.2
5	11 37 17.3	6	"	— 3 19.87	— 1 49.7	10 11 12.49	17 9 7.8
6	10 52 39.9	10	"	— 3 29.53	— 0 47.1	10 11 2.82	17 10 10.2
16	12 32 41.0	3	"	— 3 51.93	+ 1 47.8	10 10 40.32	17 12 46.1
17	10 11 7.6	3	"	— 3 47.37	+ 1 16.8	10 10 44.87	17 12 15.2
26	11 3 34.3	7	Rümker 3141	— 0 13.48	+ 8 39.8	10 12 30.30	17 1 8.0
27	8 42 40.9	10	"	+ 0 2.42	+ 6 59.4	10 12 46.19	+ 16 59 27.7

Adopted Mean Places 1858.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
Bessel's Z. 456,13	8.9	^h 10 ^m 14 ^s 30.17	[°] +17 ['] 11 ["] 2.9	Meridian Circle — Professor Brünnow. Rümker's Catalogue.
Rümker 3141	9	10 12 41.83	+16 52 32.0	

NEMAUSI.

Date.	Ann-Arbor M.T.	No. Comp.	Comparison-Star.	Planet — Star		Apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 May 6	^h 10 ^m 29 ^s 52.1	10	Bessel's Z. 237,23	^m — 1 ^s 7.35	['] + 1 ["] 20.6	^h 11 ^m 19 ^s 6.94	[°] + 8 ['] 26 ["] 2.7
7	11 23 51.3	10	"	— 0 45.17	+ 2 25.8	11 19 29.12	8 27 7.9
8	11 18 29.3	5	"	— 0 22.12	+ 3 12.8	11 19 52.16	8 27 55.0
9	12 43 15.9	5	"	+ 0 3.94	+ 3 51.4	11 20 18.21	8 28 33.7
12	8 24 39.2	3	"	+ 1 22.20	+ 4 11.4	11 21 36.44	8 28 51.0
31	9 33 40.2	6	Bessel's Z. 237,43	— 2 30.47	— 1 37.6	11 35 7.81	7 49 5.8
June 1	8 52 9.1	4	"	— 1 37.58	— 5 28.7	11 36 0.70	+ 7 45 14.7

Adopted Mean Places 1858.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
Bessel's Z. 237,23	9.0	^h 11 ^m 20 ^s 12.25	[°] + 8 ['] 24 ["] 51.7	Meridian Circle — Professor Brünnow. Bessel's Zones.
" 237,43	9	11 37 36.39	+ 7 50 52.4	

ATALANTA.

Date.	Ann-Arbor M.T.	No. Comp.	Comparison-Star.	③⑥ — *		③⑥'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 May 20	^h 10 ^m 31 ^s 4.2	3	* 1	^m — 0 ^s 5.70	['] + 1 ["] 0.4	^h 13 ^m 45 ^s 33.42	[°] — 29 ['] 50 ["] 30.8

Adopted Mean Places for 1858.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
* 1	12	^h 13 ^m 45 ^s 37.02	[°] — 29 ['] 51 ["] 9.9	Equat. from Arg. Z. 404,15. Argelander's Zones.
Argelander's Z. 404,45	8	13 43 2.57	— 29 51 30.8	

COMET-CIRCULAR.

HENRY M. PARKHURST, Esquire, of Perth-Amboy, New-Jersey, writes under date of July 5, announcing his discovery of a telescopic Comet, which he first saw June 29, and the motion of which he first recognized July 1.

He gives the position as follows :

Perth-Amboy M.T. α δ
 July 1 9^h 0^m 9^h 33^m.5 + 27° 0',

and states the motion in three days to have been + 2^m.0 in right ascension and + 18' in declination.

This Comet was detected last evening by Mr. SEARLE, Assistant in this observatory, and approximately observed by him with the comet-seeker, the position depending upon HARDING's chart. Mr. SEARLE's observation gives :

Albany M.T. α δ
 July 7 9^h 40^m 9^h 35^m.2 + 27° 17';

according very well with Mr. PARKHURST's statement.

The comet is very diffuse, and without definite nucleus.

This comet is in all probability identical with one seen by DONATI in Florence June 2, and of which he telegraphed an account to Mr. LEVERRIER June 2.

Prof. DONATI's observations gave :

	Florence M.T.	α	δ
June 2	10 ^h 17 ^m 9.9 ^s	9 ^h 24 ^m 6 ^s	+23° 55' 0"
7	10 27 5	9 24 59.3	21 21 59
8	9 37 57	9 25 2.4	23 27 41

The last observation of δ should probably be 24° 27' 41".

B. A. GOULD JR.

Dudley Observatory, 1858 July 8.

OBSERVATIONS OF PSYCHE, NEMAUSA, EUROPA, FIDES, AND COMET 1858 V,

MADE WITH THE FILAR MICROMETER OF THE WASHINGTON EQUATORIAL,

By JAMES FERGUSON.

[Communicated by Commander MAURY.—Corrected for refraction.]

PSYCHE.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	⑩ — *		⑩'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	[°] ['] ["]
1858 Apr. 16	10 17 9.9	3	Weisse XIV. 793	— 2 4.77	— 0 29.71	14 40 51.79	— 11 26 25.95
24	9 47 5.4	10	" 608	+ 1 9.09	— 7 22.42	11 34 50.83	10 52 48.43
27	9 58 43.6	4	" 608	— 1 12.57	+ 5 18.89	14 32 29.19	10 40 7.15
June 25	9 37 18.8	6	" 83	— 2 21.90	— 19 10.50	14 3 37.92	8 39 3.47
26	9 39 8.9	6	" 83	— 2 20.09	— 20 22.58	14 3 39.72	— 8 40 15.39

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
		^h ^m ^s		[°] ['] ["]	
Weisse XIV. 793	7.5	14 43 0.73	Weisse's Catalogue.	— 11 26 9.10	Y. 2.
" 608	9	14 33 45.75	"	10 45 39.41	Y. 2.
" * 83	9	14 6 3.73	"	— 8 20 10.80	Weisse's Catalogue.

NEMAUSA.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	Planet — Star		Apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	[°] ['] ["]
1858 May 13	9 40 38.2	10	B. A. C. 3911	— 0 14.02	+ 5 41.14	11 22 8.02	+ 8 28 30.94
20	9 40 26.8	3	"	+ 3 59.81	— 2 20.28	11 26 21.76	8 20 27.01
	"	3	Weisse XI. 412	+ 1 58.93	— 18 10.87	11 26 21.49	8 20 31.42
June 1	9 23 50.3	6	" 662	— 2 6.27	— 3 45.27	11 36 2.03	+ 7 45 21.97

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
		^h ^m ^s		[°] ['] ["]	
B. A. C. † 3911	7	11 22 26.25	British Assoc. Cat.	+ 8 22 16.62	British Assoc. Catalogue.
Weisse XI. 412	8	11 24 26.85	Weisse's Catalogue.	8 38 11.58	Weisse's Catalogue.
" 662	8	11 38 12.58		+ 7 48 36.37	

* This star is double.

† This star is Weisse XI. 381. The α in Weisse is erroneous; it was used in the comparison of this observation published in No. 113 of the *Astronomical Journal*.

EUROPA.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	Planet — Star		Apparent	
				$\lambda\alpha$	$\lambda\delta$	α	δ
1858 May 13	9 0 52.2	10	Rümker 3203	— 0 45.27	— 15 25.00	10 20 5.87	+ 16 13 16.04
20	8 43 10.7	3	" 3238	— 1 18.84	— 11 58.68	10 24 40.11	15 44 35.12
21	9 37 56.9	5	" 3238	— 0 34.28	— 16 26.37	10 25 24.11	15 40 7.38
22	8 47 55.7	4	B. Z. 457.12	+ 0 10.77	— 1 50.48	10 26 6.73	15 25 43.59
June 7	9 6 13.8	5	Weisse X. 702	— 0 25.38	+ 4 13.65	10 39 29.87	+ 14 11 39.84

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
Rümker 3203	7	10 20 55.82	+ 16 28 8.03	Rümker's Catalogue.
" 3238	8	10 26 3.11	15 56 0.46	
B. Z. 457.12	8	10 26 0.70	+ 15 37 0.71	Washington Equatorial.

FIDES.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	③7 — *		③7's apparent	
				$\lambda\alpha$	$\lambda\delta$	α	δ
1858 Jun. 29	9 54 49.8	3	A. Z. 387.10	— 0 46.85	— 1 43.64	15 39 18.26	— 23 25 32.09
30	9 14 33.0	5	" "	1 13.15	+ 0 18.22	15 38 51.95	23 23 30.17
July 6	9 30 6.0	6	" 387.6	0 27.70	— 8 47.06	15 36 41.38	23 12 32.23
7	9 51 41.1	10	" "	0 15.10	— 7 9.95	15 36 23.96	23 10 55.23
8	9 43 57.1	7	" "	— 1 0.13	— 5 32.08	15 36 8.92	— 23 9 17.49

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
A. Z. 387.10	6	15 40 9.09	Argelander's Zones.	— 23 23 53.40	Y. 5.
" 387.6	8	15 37 13.07	"	— 23 3 50.50	Argelander's Zones.

COMET 1858 V.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	♄ — *		♄'s apparent	
				$\lambda\alpha$	$\lambda\delta$	α	δ
1858 July 9	9 17 48.8	2	B. Z. 349.71	— 2 44.63	— 6 46.44	9 35 50.38	+ 27 27 52.82
10	8 56 59.9	6	" 349.70	— 1 16.27	— 8 43.93	9 33 27.19	27 33 11.85
"	"	6	" 349.71	— 2 7.63	— 1 22.38	9 36 27.40	27 33 16.82
11	9 0 21.2	10	" 349.70	— 0 37.72	— 3 8.00	9 37 5.75	27 38 47.82
14	8 45 20.9	3	" 349.70	+ 1 23.80	+ 13 38.29	9 39 7.27	27 55 33.31
15	8 49 13.1	10	" 349.72	+ 1 6.01	+ 12 30.02	9 39 49.82	28 1 15.23
16	8 38 3.2	4	" 349.72	+ 1 49.12	+ 18 12.38	9 40 32.95	28 6 57.51
17	8 39 36.1	3	" 349.77	— 4 32.87	— 8 50.48	9 41 17.91	28 12 52.31
21	8 37 54.1	5	" 349.77	— 1 26.13	+ 11 21.78	9 41 24.41	+ 28 36 4.20

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
B. Z. 349.71	9	9 38 40.69	+ 27 34 4.27	Bessel's Zones.
" 349.70	8	9 37 49.16	+ 27 41 20.89	

FROM A LETTER OF PROFESSOR SAWITSCH, TO THE EDITOR.

St.-Petersburg Observatory, 1858 June $\frac{24}{12}$.

HEREWITH I inclose you observations of the opposition of *Neptune*.—The positions of the planet are for the time of culmination at St.-Petersburg, the declinations being already freed from the influence of parallax and refraction. The places of the comparison-stars α and γ *Aquarii* are taken from the English Nautical Almanac; that of 96 *Aquarii*, from the British Association Catalogue.

OPPOSITION OF NEPTUNE IN 1855.

Date.		Ψ α	Ψ δ
September	7	23 ^h 13 ^m 20.05	—6° 12' 33.2
	11	12 55.30	15 12.0
	22	11 49.52	22 13.9
	23	11 43.40	22 55.5
	25	11 31.68	24 3.5
	26	23 11 25.63	—6 24 41.1

OPPOSITION OF NEPTUNE IN 1856.

August	30	23 ^h 22 ^m 39.51	—5° 16' 52.3
	31	22 33.30	17 36.0
September	4	22 9.88	20 15.2
	5	22 3.86	20 51.6
	6	21 57.80	21 32.7
	7	21 51.80	22 11.3
	9	21 39.45	23 26.2
	10	21 33.50	24 3.6
	11	21 27.80	24 42.3
	14	21 9.60	26 49.7
	19	20 39.50	29 59.8
	22	20 21.40	31 55.3
	23	20 15.00	32 32.4
	28	23 19 46.00	—5 35 42.0

OPPOSITION OF NEPTUNE IN 1857.

Date.		Ψ α	Ψ δ
August	30	23 ^h 31 ^m 15.65	—4° 25' 16.9
	31	31 10.15	25 57.5
September	2	30 58.08	27 15.8
	3	30 52.27	27 58.4
	5	30 40.06	29 44.5
	7	30 28.00	30 32.7
	8	30 22.20	31 11.2
	10	30 10.08	32 31.3
	13	29 52.21	34 37.1
	15	29 39.83	35 51.0
	24	23 28 45.27	—4 41 37.6

QUADRATURE OF NEPTUNE IN 1857.

November	17	23 ^h 21 ^m 53.91	—5° 5' 22.2
	19	51.15	5 37.5
	27	42.90	6 7.4
	30	41.34	6 10.3
December	11	23 24 53.17	—5 4 37.9

The following occultations of the Pleiades by the moon have been observed by me :

		St.-Petersburg M.T.
1857 Oct. 6	23, <i>d</i> <i>Pleiadum</i>	Immersion 8 ^h 57 ^m 43.5
		Emersion 9 27 27.5
" "	27, <i>f</i> <i>Pleiadum</i>	Immersion 9 50 41.5
" 30	27, <i>f</i> <i>Pleiadum</i>	" 7 12 41.0
" "	28, <i>h</i> <i>Pleiadum</i>	" 7 22 30.0

The United States Coast-Survey Office did me the honor

to invite me to observe the Pleiades-occultation of Dec. 27, 1857. I have taken pains to prevent the phenomenon from passing unobserved; but the moon was so near the horizon, that the brightest of the occulted stars, 23, *Mecope*, was scarcely visible.

The immersion took place at about 18^h 12^m 30^s St.-Petersburg M.T.; but I consider this as being an estimate rather than an observation.

A. SAWITSCH.

TOTAL ECLIPSE OF SEPTEMBER 1858.

ASTRONOMERS will learn with pleasure that Lieut. GILLISS designs visiting Peru for the purpose of observing the total eclipse of September next. By the liberality of WILLIAM WHEELWRIGHT, Esquire, of Newburyport (Mass.), the necessary means have been supplied to cover the expenses of an astronomer for this purpose, under the auspices of the Smithsonian Institution: Lieut. GILLISS has been designated as the astronomer, and will leave by the steamer of August 5 for Panama. His long experience in Chile, and intimate acquaintance with South-American life, conjoined with his astronomical skill and thorough equipment, warrant the anticipation of valuable results. The Smithsonian Institution and the Coast Survey have lent the necessary instruments and

equipments, excepting a 4½ inch equatorial, preparing by Mr. FITZ of New-York. The steamship and railroad companies New-York to Valparaiso have invited Lieut. GILLISS to accept a free passage out and back, and offered every other facility possible.

An expedition of astronomers has also been organized in England. For the observation of the phenomena, Mr. CARINGTON has prepared a valuable collection of rules and suggestions, which have been published by the Lords Commissioners of the British Admiralty.

The Comet 1858 V will then be not far from the sun, and will doubtless present a magnificent appearance — adding

greatly to the impressiveness of the scene. As it will not probably be far from the horizon at twilight during its entire period of visibility, the opportunity for noticing its physical

aspect during the eclipse will be unsurpassed, if it were reasonable to expect the attention of observers to be withdrawn from the solar disc.

G.

COMET 1858 V.

Of this remarkable body discovered June 2 by DONATI in Florence, and June 29 by PARKHURST in Perth-Amboy, the following observations are at hand in addition to those of Mr. FERGUSON given in the present number.

OBSERVATIONS.

1858.	Place.	M.T. of Place.	α	δ
June 7	Florence	10 ^h 27 ^m 5 ^s	9 ^h 24 ^m 59.33	+24° 21' 58.6
8	"	9 37 57	9 25 2.40	24 27 50.7
9	"	10 52 1	9 25 5.31	24 34 46.5
10	"	9 57 54	9 25 9.63	24 41 8.3
11	"	10 25 41	9 25 15.84	24 47 38.4
12	Padua	9 39 26	9 25 21.90	24 53 34.2
"	Florence	10 35 2	9 25 21.06	24 53 59.9
13	Padua	9 41 27	9 25 30.11	24 59 25.5
"	Florence	10 19 41	9 25 28.70	25 0 18.1
"	Berlin	11 7 17	9 25 30.79	24 59 47.4
14	"	10 35 37	9 25 39.70	25 5 48.6
"	Vienna	10 55 21	9 25 40.86	25 5 54.3
15	Florence	9 57 22	9 25 53.16	25 11 19.7
"	Vienna	10 41 51	9 25 51.77	
"	Berlin	10 52 55	9 25 50.31	25 12 1.4
16	"	10 43 40	9 26 2.35	25 17 46.2
17	Florence	10 1 1	9 26 17.92	25 23 23.2
19	"	9 34 49	9 26 46.63	25 35 29.4
"	Padua	9 51 49	9 26 41.38	+25 35 35.4

The extremely slow motion of this comet was at first its most striking characteristic, its great distance and the direc-

Dudley Observatory, 1858 July 29.

tion of its motion combining to render the apparent geocentric motion very small. The great dissimilarity of the successively computed parabolas formed also a remarkable feature; and the great deviation of the middle place from the computed parabolic orbit seems to point distinctly to the high probability of a well-marked eccentricity.

From normal places constructed for June 9 and 15 from observations at Florence and Berlin, and July 11 from Washington observations, Mr. GEORGE SEARLE, Assistant at this Observatory, has computed the following parabolic elements:

$$\begin{aligned} T &= \text{Sept. } 13^{\text{d}}.48366 \text{ Washington M.T.} \\ \pi &= 29^{\circ} 35' 22.1 \\ \Omega &= 166^{\circ} 14' 27.3 \\ i &= 67^{\circ} 57' 15.1 \\ \log q &= 9.6205654 \end{aligned} \left. \begin{array}{l} \\ \\ \\ \end{array} \right\} \text{Equinox 1858.0}$$

Motion Retrograde.

These elements have a strong resemblance to those of the First Comet of 1827, of which, however, we have but ten recorded observations, all of them between 1826 Dec. 27 and 1827 Jan. 26; and they are not dissimilar to those of the Comet of 1764.

Comparison with the middle place gives the large residuals

$$\begin{aligned} \Delta \alpha \cos \delta &= -3' 44.9 \\ \Delta \delta &= +1' 40.6. \end{aligned}$$

G.

CORRIGENDA.

MR. FERGUSON sends the following correction:

In the observations of the Comet 1857 IV, published page 133 of the present volume, the α given for * 2 should have been as follows:

$$\begin{aligned} &a \ 1860.0 \\ &7^{\text{h}} \ 1^{\text{m}} \ 18^{\text{s}}.55. \end{aligned}$$

The α of the Comet for August 23 becomes $7^{\text{h}} \ 0^{\text{m}} \ 18^{\text{s}}.07$.

Mr. WATSON sends the following for the observations of *Hestia* in N° 113:

$$\begin{aligned} \text{Oct. 16} \quad \text{Time for} \quad &10^{\text{h}} \ 13^{\text{m}} \ 51^{\text{s}}.5 \quad \text{read} \quad 9^{\text{h}} \ 13^{\text{m}} \ 51^{\text{s}}.5 \\ \text{Oct. 21} \quad \alpha \quad &9 \ 15 \ 33.8 \quad \alpha \quad 8 \ 15 \ 43.8 \end{aligned}$$

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COMET 1858 V.

CORRIGENDA.

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ALBANY, 1858, SEPTEMBER 21.

NO. 20.

ON THE ORBIT OF HESTIA.

BY JAMES C. WATSON.

THE observations of *Hestia* $\text{\textcircled{46}}$ during the period of its visibility in 1857 are few in number, and include an interval of only two months. Moreover, by far the greater number of these were made during the twelve days next succeeding the discovery of the planet, and those taken in September and October are barely sufficient for the formation of normal places for their respective dates. In order that the entire series of observations might be available for the determination of the orbit, an ephemeris was computed from the following approximate elements.

Epoch = 1857 August 30.5 Washington M.T.

$$\begin{array}{rcl} M & = & 333^{\circ} 26' 20.5 \\ \pi & = & 351\ 14\ 27.7 \\ \Omega & = & 181\ 25\ 59.5 \\ i & = & 2\ 17\ 50.8 \\ q & = & 9\ 29\ 35.7 \\ \log a & = & 0.403549 \\ \log \mu & = & 2.944683 \\ \mu & = & 880''.406 \end{array} \left. \vphantom{\begin{array}{rcl} M \\ \pi \\ \Omega \\ i \\ q \\ \log a \\ \log \mu \\ \mu \end{array}} \right\} \text{Mean Equinox 1857.0}$$

The comparison of all the observations which have yet been published, with this ephemeris, gave the following residuals :

1857.	$\Delta\alpha$	C.—O.	$\Delta\delta$	Place of Observation.
August 16	—28.7		—10.6	Oxford
"	—33.4		—11.9	"
"	—38.2		—12.3	"
17	—25.9		—2.1	"
22	—22.4		—8.0	"
"	—12.5		—3.8	Cambridge (England)
"	—11.1		—2.9	Oxford
23	—15.3		—5.1	Bonn
24	—9.0		+ 0.4	Vienna
"	—14.0		—0.7	Bonn
"	+ 0.6		—5.5	Leyden
25	—7.3		—7.9	Vienna
"	—9.2		—2.5	Cambridge (England)
"	—12.2		+ 0.6	Bonn
"	—1.4		—2.5	Leyden
"	—19.4			Oxford
"	—7.9		—2.5	"
26	—0.4		+ 5.2	Leyden
"	—12.6		—4.4	Bonn
"	—11.2			Oxford
"	—5.9		+ 0.8	"

1857.	$\Delta\alpha$	C.—O.	$\Delta\delta$	Place of Observation.
August 26			—3.2	Oxford
27	—5.7		—4.0	Vienna
"	(+19.6)		—0.8	Leyden
28	—5.3			Cambridge (England)
"	—17.3		+ 0.4	Bonn
"	—2.4		+ 2.3	"
"	+ 1.3		+ 5.3	Berlin
29	+ 1.5		+ 1.1	Leyden
"	—10.0		+ 0.5	Bonn
"	—6.7		—0.5	Oxford
30	+ 3.9		0.0	Leyden
"	+ 0.6		—1.1	Bonn
Septem. 8	+ 7.4		+ 5.8	Berlin
17	—7.2		—3.8	Oxford
18	—4.7		—0.4	"
23	—2.1		+ 4.0	Cambridge (England)
October 5	—15.4		—0.4	"
16	—40.9		—5.3	Ann-Arbor
17	—37.5		—5.8	"
20	—41.0		0.0	"
21	—44.6		—2.9	"

The following normal places will therefore represent the observations of *Hestia* in 1857 :

1857 Wash. M.T.	$\text{\textcircled{46}}\ \alpha$	$\text{\textcircled{46}}\ \delta$	No. of Obs.
Aug. 16.5	305° 3' 25.2	—16° 22' 4.0	2
26.5	303 33 54.4	16 58 33.2	26
Sept. 19.5	303 7 47.9	17 48 35.6	3
Oct. 18.5	308 32 50.4	—17 22 35.7	4

From the normal places of August 26, September 19, and October 18, the following elements have been derived :

Epoch = 1857 September 19.5 Washington M. T.

$$\begin{array}{rcl} M & = & 337^{\circ} 57' 30.38 \\ \pi & = & 355\ 4\ 0.71 \\ \Omega & = & 181\ 26\ 7.54 \\ i & = & 2\ 17\ 48.29 \\ q & = & 9\ 45\ 28.84 \\ \log a & = & 0.4048283 \\ \log \mu & = & 2.9427641 \\ \mu & = & 876''.52464 \end{array} \left. \vphantom{\begin{array}{rcl} M \\ \pi \\ \Omega \\ i \\ q \\ \log a \\ \log \mu \\ \mu \end{array}} \right\} \text{Mean Equinox 1857.0}$$

The comparison of these elements with the above normals gives the following residual errors :

		C.—0.	$\Delta\delta$
1857.			
August	16.5	(—11.09)	(— 9.62)
	26.5	— 0.12	— 0.15
September	19.5	— 0.01	— 0.19
October	18.5	+ 0.02	— 0.07

A very close agreement with the normal place of August 16

could not of course be expected, on account of the small number and uncertainty of the observations upon which it depends.

It is my intention to compute the perturbations and furnish an ephemeris for the next opposition, which occurs about the beginning of December of the present year.

Ann Arbor, 1858 July 30.

LETTERS FROM MR. C. W. TUTTLE TO THE EDITOR.

Boston, 1858 August 2.

I HAVE derived the following parabolic elements of Comet 1858 V from a Washington observation of July 10th, and Cambridge observations of July 15th and 19th.

$$\begin{aligned} T &= 1858 \text{ Sept. } 22.19109 \text{ Greenwich M.T.} \\ \pi &= 32^\circ 44' 25'' \\ \Omega &= 165^\circ 48' 50'' \\ i &= 61^\circ 51' 40'' \\ \log q &= 9.69398 \end{aligned} \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} \text{Mean Equinox 1858.0}$$

Motion Retrograde.

These elements satisfy the middle place as follows :

$$\begin{aligned} \Delta\alpha \cos \delta &= +11'.5 \\ \Delta\delta &= -2''.6 \end{aligned}$$

C. W. TUTTLE.

Boston, 1858 September 14.

I HAVE derived the following parabolic elements of Comet 1858 VII, discovered at Harvard College Observatory September 5, from observations made there Sept. 5th, 7th & 9th.

$$\begin{aligned} T &= 1858 \text{ Oct. } 17.038128 \text{ Greenwich M.T.} \\ \pi &= 1^\circ 30' 23'' \\ \Omega &= 158^\circ 58' 0'' \\ i &= 21^\circ 5' 47'' \\ \log q &= 0.15267 \end{aligned} \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} \text{Mean Equinox 1858.0}$$

Motion Retrograde.

These elements satisfy the middle place as follows :

$$\begin{aligned} \Delta\alpha \cos \delta &= -26''.0 \\ \Delta\delta &= -1''.8 \end{aligned}$$

C. W. TUTTLE.

LETTER FROM PROFESSOR ENCKE TO THE EDITOR.

Berlin, 1858 August 11.

AFTER my long silence, I cannot refrain from writing to announce to you the return of Pons's Comet, that you may at least see that your old friend has not forgotten you.

By the assistance of the excellent observations of Mr. MACLEAR in 1855 at the Cape of Good Hope, and with the *Jupiter* perturbations computed for me by Mr. POWALKY, I had deduced the following elements for 1858, after taking the diminution of the period into account.

$$\begin{aligned} &1858 \text{ October } 18.5 \text{ Berlin.} \\ L &= 157^\circ 59' 18''.0 \\ M &= 0^\circ 1' 48''.0 \\ \pi &= 157^\circ 57' 30''.0 \\ \Omega &= 331^\circ 28' 34''.0 \\ i &= 13^\circ 4' 15''.0 \\ \log a &= 0.3159881 \\ \mu &= 1074''.05 \end{aligned}$$

With these, Mr. POWALKY has computed the accompanying ephemeris. On the first evening upon which we could entertain any hope, the comet was looked for here; and Dr. FÖRSTER found it almost immediately, as soon as his eye had sufficiently adapted itself to the perception of faint objects. It presents an excessively faint nebulous appearance of about 1 minute

in diameter. This was August 7. Since then he has observed it both on the 9th and 10th, as follows :

1858.	Berlin M.T.	$\angle \alpha$	$\angle \delta$
Aug. 7	13 ^h 26 ^m 39 ^s .4	4 ^h 12 ^m 41 ^s .61	+31° 24' 45".6
9	11 12 7	20 53.21	31 55 18.4
10	13 28 8	4 21 56.96	+32 9 52.3

The comparison with ephemeris gives

	C.—0.	$\Delta\alpha$	$\Delta\delta$
Aug. 7		—2.17	+19.1
9		—1.48	+11.9
10		—1.40	— 2.8

The ephemeris is therefore completely trustworthy, and will serve to find the comet during its whole period of visibility. During September, and at the beginning of October, the comet will be considerably brighter. I beg you to endeavor to secure American observations during these months. From the year 1819 up to the present date, no return has passed unobserved in the northern or the southern hemisphere. In future, thanks to Mr. MACLEAR, the observations in the latter will not fall behind the European ones in precision.

ENCKE.

EPIHEMERIS OF ENCKE'S COMET FOR BERLIN MEAN MIDNIGHT.

1858	$\angle \alpha$	$\angle \delta$	$\log \Delta$	$\log r$	1858	$\angle \alpha$	$\angle \delta$	$\log \Delta$	$\log r$
	^h ^m ^s	[°] ['] ^{''}				^h ^m ^s	[°] ['] ^{''}		
Aug. 7	1 12 26.92	+31 24 21.6	0.165443	0.159333	Sept. 9	7 36 10.17	+33 57 21.2	9.977917	9.973974
8	16 25.86	31 39 23.8	159557	155183	10	45 22.88	33 35 1.9	974222	966091
9	20 30.75	31 51 19.3	153632	150968	11	7 51 10.52	33 9 55.9	970816	958011
10	24 41.84	32 9 6.5	117669	146686	12	8 3 2.15	32 41 59.7	967715	949723
11	28 59.35	32 23 44.0	141671	142336	13	11 56.84	32 11 10.5	964941	944219
12	33 23.54	32 38 9.9	135611	137915	14	20 53.64	31 37 26.5	962515	932190
13	37 51.65	32 52 22.3	129582	133422	15	29 51.56	31 0 47.6	960151	923527
14	42 32.96	33 6 19.0	123498	128854	16	38 49.61	30 21 14.9	958767	914319
15	47 18.76	33 19 57.8	117390	124209	17	47 46.83	29 38 50.2	957176	904857
16	52 12.33	33 33 16.2	111263	119484	18	8 56 42.28	28 53 36.3	956593	895129
17	4 57 13.94	33 46 11.4	105122	114677	19	9 5 35.10	28 5 36.7	956128	885124
18	5 2 23.87	33 58 40.2	098972	109787	20	11 24.51	27 11 58.5	956092	874830
19	7 42.39	34 10 39.4	092816	104809	21	23 9.75	26 21 47.4	956492	864236
20	13 9.76	34 22 5.3	086662	099742	22	31 50.11	25 26 10.8	957335	853328
21	18 16.23	34 32 54.1	080515	094583	23	40 25.09	24 28 16.7	958625	842098
22	24 32.06	34 43 1.5	074382	089328	24	48 54.22	23 28 13.8	960361	830534
23	30 27.51	34 52 23.0	068270	083975	25	9 57 17.12	22 26 11.2	962511	818625
24	36 32.79	35 0 53.8	062187	078520	26	10 5 33.49	21 22 18.0	965170	806358
25	42 48.09	35 8 28.8	056141	072960	27	13 43.20	20 16 43.5	968232	793726
26	49 13.53	35 15 2.3	050111	067290	28	21 46.22	19 9 37.1	971723	780722
27	5 55 49.42	35 20 28.4	044197	061508	29	29 42.59	18 1 7.7	975632	767342
28	6 2 35.70	35 24 41.1	038321	055609	30	37 32.45	16 51 24.2	979946	753587
29	9 32.45	35 27 31.0	032522	049589	Oct. 1	45 16.08	15 40 31.0	984650	739462
30	16 39.68	35 29 0.1	026813	043445	2	10 52 53.84	14 28 44.4	989729	724983
31	23 57.32	35 28 52.3	021207	037170	3	11 0 26.14	13 16 2.4	9995163	710163
Sept. 1	31 25.23	35 27 3.4	015718	030761	4	7 53.49	12 2 31.7	0.000929	695035
2	39 3.26	35 23 26.7	010360	024212	5	15 16.55	10 48 26.1	007005	679660
3	46 51.13	35 17 54.0	005119	017518	6	22 36.06	9 33 40.5	013364	664122
4	6 54 48.47	35 10 18.0	0.000102	010673	7	29 52.78	8 18 22.8	019977	648511
5	7 2 54.89	35 0 31.3	9.995236	0.003672	8	37 7.53	7 2 36.5	026814	632906
6	11 9.93	34 48 27.0	990565	9.996508	9	44 21.11	5 46 25.1	033838	617522
7	19 32.95	34 33 58.1	986109	989175	10	51 34.47	4 29 52.0	041008	602605
8	7 28 3.27	+34 16 58.2	9.981886	9.981666	11	11 58 48.36	+3 12 59.8	0.048278	9.588242

ELEMENTS AND EPIHEMERIS OF THE FIFTH COMET OF 1858.

BY JAMES C. WATSON.

THE great dissimilarity of the elements of the orbit of this interesting comet, computed from observations at different intervals, has induced me to undertake, at this time, to determine from a greater number of observations, and including a much greater interval of time, a new system of parabolic elements, and also to determine whether there is any probability of an eccentricity less than that of the parabola. I have, therefore, by means of approximate elements, constructed normal places for June 11, July 13, and August 14 : the first from observations at Florence, Padua, and Berlin ; the second from observations at Washington and Cambridge (Mass.) ; and the third from the following observations :

1858	Ann-Arbor M.T.	$\angle \alpha$	$\angle \delta$
Aug. 12	8 ^h 25 ^m 30 ^s .8	151° 42' 31.3	+31° 8' 7.7
13	8 19 7.1	152 1 27.9	31 16 9.1
14	7 59 28.4	152 20 55.2	31 24 29.7
15	8 8 41.6	152 41 13.7	+31 33 18.0

The normal places are the following, and are referred to the apparent equinox of the date :

1858	Wash. M.T.	$\angle \alpha$	$\angle \delta$	No. of Obs.
June	11.0	141° 18' 30.9	+24° 46' 25.4	10
July	13.0	144 32 49.7	27 48 0.8	9
Aug.	14.0	152 14 12.0	+31 21 47.9	4

Assuming an approximate value of $\log \Delta$, and varying it so that the sum of the squares of the residuals in the middle place, or $(\Delta \cos \beta)^2 + (\Delta \beta)^2$, shall be a minimum, the following corrected elements are obtained from the above normal places:

$$\begin{aligned} T &= 1858 \text{ Sept. } 29.794381 \text{ Washington M.T.} \\ \pi &= 36^\circ 20' 11.5'' \\ \Omega &= 165^\circ 15' 49.7'' \\ i &= 63^\circ 3' 6.0'' \\ \log q &= 9.763374 \\ &\text{Motion Retrograde.} \end{aligned}$$

The comparison of the middle place with these elements gives the following residual error:

$$\begin{aligned} \Delta \cos \delta &= -0.9 \\ \Delta \delta &= -7''.4 \end{aligned}$$

It is evident, therefore, considering the great interval of sixty-four days between the extreme places used in the computation of these elements, and the number of observations employed in the formation of the normals, that the ellipticity of the orbit which has hitherto been suspected, in case it really exists, must be extremely small; and it is unnecessary, for the present at least, to abandon the parabolic hypothesis in the computation of elements.

The above parabolic elements give the following

Ephemeris for Washington Mean Midnight.

1858.	$\ell \alpha$	$\ell \delta$	$\log \Delta$
Aug. 14	10 ^h 9 ^m 31 ^s	+31° 26'.1	0.30894
18	10 15 7	32 1.2	0.29464
22	10 21 15	+32 38.8	0.27198

1858.	$\ell \alpha$	$\ell \delta$	$\log \Delta$
Aug. 26	10 ^h 28 ^m 6 ^s	+33° 18'.6	0.24956
30	10 35 53	34 0.4	0.23395
Sept. 3	10 44 52	34 43.2	0.19457
7	10 55 27	35 25.0	0.16072
11	11 8 15	36 1.8	0.12152
15	11 21 7	36 26.3	0.07598
19	11 41 16	36 24.5	0.02309
23	12 10 14	35 31.4	9.96220
27	12 43 40	33 3.2	9.89408
Oct. 1	13 25 16	27 53.0	9.82332
5	14 13 25	18 49.7	9.76231
9	15 3 29	+ 5 59.5	9.73184
13	15 49 57	- 7 56.7	9.74589
17	16 29 28	-19 45.4	9.79176

This ephemeris is referred to the mean equinox of 1858.0

If we suppose the intensity of the light of the comet to vary inversely as the product $r^2 \Delta^2$, the relative brilliancy from August 4 to October 17 will be as follows:

Date.	Brilliancy.	Date.	Brilliancy.
1858 Aug. 14	1.00	1858 Sept. 23	17.57
22	1.90	27	25.27
30	2.45	Oct. 1	35.14
Sept. 7	4.35	5	44.55
15	8.46	9	47.12
19	12.11	17	27.58

On August 14, the comet appeared as bright as a star of the 4.5 magnitude; and we may expect, therefore, that it will present a magnificent appearance, in the west after sunset, about the beginning of October.

Ann Arbor, 1858 August 25.

ELEMENTS OF VIRGINIA, AND AN EPHEMERIS FOR THE OPPOSITION IN 1859.

BY JOHN N. STOCKWELL.

THE Ephemeris is derived from the following elements, with the addition of the perturbations by *Jupiter* and *Saturn*.

ELEMENTS OF VIRGINIA.

$$\begin{aligned} 1857 \text{ Oct. } 2.0 \quad M &= 0^\circ 58' 30.7 \text{ Washington M.T.} \\ \Omega &= 173^\circ 29' 38.9'' \\ \pi &= 10^\circ 20' 54.9'' \\ i &= 2^\circ 47' 41.5'' \\ q &= 16.41 \text{ 0.0} \\ \log a &= 0.4232943 \\ \log \mu &= 2.9150696 \end{aligned}$$

The integrated perturbations by *Jupiter* and *Saturn*, from 1857 Oct. 2, till 1859 March 6, are

$$dM = -291''.44, \quad d\Omega' = +12''.32, \quad d\pi = -597''.59, \quad di' = +0''.082, \quad dq = +24''.01, \quad d\mu = +0''.6350.$$

The perturbations $d\Omega'$ and di' are referred to the equator as the fundamental plane.

EPHEMERIS OF VIRGINIA FOR WASHINGTON MEAN NOON.

1858	$\odot \alpha$	$\odot \delta$	$\log \Delta$	$\log r$	1859	$\odot \alpha$	$\odot \delta$	$\log \Delta$	$\log r$
Dec. 16	160 9 2.2	+ 6 29 4.9	0.41043	0.47519	Feb. 16	153 50 1.6	+ 9 9 4.2	0.33011	
20	21 31.0	23 46.6	40255	47658	17	36 51.0	14 40.6	33025	
24	28 44.6	20 38.1	39471	47796	18	23 39.2	20 17.5	33045	0.19529
28	30 33.2	19 45.8	38698	47932	8 19	153 10 27.2	25 54.7	33072	
1859					20	152 57 15.4	31 32.0	33101	
Jan. 1	26 50.3	21 11.3	37942	48066	21	44 4.6	37 8.9	33143	
2	25 1.8	21 55.6	37756		22	30 55.6	42 15.1	33188	49639
3	22 52.3	22 48.9	37572		23	17 49.4	48 20.5	33239	
4	20 21.4	23 50.9	37390		24	152 4 46.6	53 54.5	33297	
5	17 29.9	25 1.7	37210	48198	25	151 51 47.9	9 59 27.0	33361	
6	14 17.2	26 21.4	37032		26	38 54.3	10 4 57.5	33420	49747
7	10 43.5	27 50.0	36855		27	26 6.3	10 26.3	33506	
8	6 48.8	29 27.7	36681		28	13 24.6	15 52.3	33587	
9	160 2 33.4	31 13.7	36511	48328	Mar. 1	151 0 50.2	21 15.5	33671	
10	159 57 57.2	33 9.6	36343		2	150 18 24.2	26 35.7	33767	49854
11	53 0.7	35 13.6	36176		3	36 6.8	31 52.6	33865	
12	47 43.5	37 26.5	36012		4	23 58.8	37 5.9	33969	
13	42 6.2	39 48.1	35853	48456	5	12 0.7	42 15.0	34079	
14	36 8.6	42 18.2	35696		6	150 0 13.5	47 20.8	34196	49959
15	29 51.0	44 57.0	35541		7	149 48 37.9	52 22.0	34317	
16	23 14.0	47 41.1	35390		8	37 14.7	10 57 18.5	34444	
17	16 17.5	50 39.5	35243	48583	9	26 4.2	11 2 10.1	34575	
18	9 1.8	53 43.2	35099		10	15 7.2	6 56.8	34711	50062
19	159 1 27.0	6 56 54.9	34959		11	149 4 24.0	11 38.4	34852	
20	158 53 33.4	7 0 14.6	34822		12	148 53 55.2	16 14.5	34999	
21	45 21.4	3 42.4	34690	48707	13	43 41.4	20 41.7	35150	
22	36 51.2	7 18.1	34562		14	33 42.7	25 9.4	35304	50163
23	28 3.1	11 1.3	34437		15	23 59.9	29 28.2	35463	
24	18 57.7	14 52.2	34317		16	14 33.2	33 10.9	35628	
25	158 9 35.1	18 50.5	34202	48830	17	148 5 23.0	37 47.7	35796	
26	157 59 56.1	22 55.6	34091		18	147 56 29.5	41 48.2	35968	50263
27	50 0.8	27 7.8	33985		19	47 53.2	45 42.4	36144	
28	39 49.7	31 26.9	33881		20	39 34.1	49 30.3	36324	
29	29 23.3	35 52.4	33787	48951	21	31 32.7	53 11.7	36507	
30	18 42.3	40 21.3	33695		22	23 19.5	11 56 46.6	36693	50361
31	157 7 47.3	45 2.4	33609		23	16 24.6	12 0 11.9	36883	
Feb. 1	156 56 38.3	49 46.3	33528		24	9 18.2	3 36.4	37077	
2	45 16.5	54 35.7	33453	49070	25	147 2 29.5	6 51.1	37274	
3	33 42.3	7 59 30.4	33383		26	146 56 0.6	9 58.9	37473	50457
4	21 56.4	8 4 30.3	33319		27	49 50.9	12 39.9	37676	
5	156 9 59.7	9 34.7	33261		28	44 0.4	15 53.8	37881	
6	155 57 52.7	14 43.5	33208	49187	29	38 29.5	18 10.8	38089	
7	45 36.1	19 56.3	33161		30	33 18.4	21 20.7	38299	50551
8	33 10.8	25 12.9	33120		31	28 26.9	23 53.7	38512	
9	20 37.4	30 33.1	33085		April 1	23 55.1	26 19.5	38727	
10	155 7 56.8	35 56.5	33056	49303	2	19 43.1	28 38.1	38944	
11	154 55 9.6	41 22.6	33031		3	15 50.9	30 49.5	39163	50644
12	42 16.5	46 51.2	33017		4	12 18.6	32 54.0	39384	
13	29 18.5	52 21.8	33006		5	9 6.2	34 51.1	39607	
14	16 16.1	8 57 54.5	33001	0.49417	6	6 13.8	36 40.9	39831	
15	154 3 10.2	+ 9 3 28.7	0.33003		7	146 4 41.7	+12 38 23.5	0.40057	0.51636

δ 1859 Feb. 19, 10^h 49^m 26^s.9. r is the undisturbed radius-vector in ellipse of 1857 Oct. 2.

Brecksville, Ohio, 1858 September 13.

FIFTH COMET OF 1858.

Of this Comet, which is now presenting so magnificent an appearance in the West after sunset and in the East before sunrise, the following additional European observations are compiled from the *Astronomische Nachrichten*, and the Meteorological Bulletin of Mr. LE VERRIER.

1858.	Place.	M.T. of Place.	α	δ
Jun. 28	Florence	9 ^h 47 ^m 5 ^s	9 ^h 29 ^m 57 ^s 5	+26° 26' 9.5
29	"	9 46 6	9 30 23.6	26 31 44.6
30	"	9 37 6	9 30 50.9	26 37 9.5
"	Vienna	10 11 42	9 30 19.4	26 37 20.9
July 2	Florence	9 40 13	9 31 47.6	26 48 15.2
8	"	9 45 10	9 35 7.5	27 20 51.4
9	Vienna	10 8 3	9 35 42.1	27 26 42.3
10	Florence	9 33 16	9 36 19.9	27 32 1.2
12	"	9 30 33	9 37 35.9	27 43 11.5
13	"	9 30 45	9 38 17.5	27 48 44.8
14	"	9 26 44	9 38 58.2	27 54 16.4
19	"	9 21 13	9 42 40.6	28 22 33.1
20	"	9 11 59	9 43 25.7	28 28 44.9

1858.	Place.	M.T. of Place.	α	δ
July 31	Florence	9 ^h 9 ^m 23 ^s	9 ^h 53 ^m 4 ^s 3	29° 37' 51"
Aug. 1	"	9 2 22	9 57 16.2	30 5 7.2
5	"	8 57 11	9 58 21.7	30 12 51.6
"	Kremsmünster	8 58 8	9 58 19.9	30 12 38.2
6	Florence	8 45 58	9 59 25.7	30 19 45.4
10	Kremsmünster	8 53 52	10 4 3.9	30 50 20.3
11	"	8 56 36	10 5 16.7	30 58 10.7
12	"	8 56 7	10 6 30.5	31 6 15.0
16	Florence	8 38 40	10 11 45.4	+31 39 22.3

The elements given by Mr. WATSON in the present number represent the series of observations excellently.

The appearance of the Comet, during the first weeks of October, promises to be truly splendid; its brilliancy at that time being more than four times as great as to-day. The nucleus seemed this morning as bright as a star of the 1.2 magnitude, and the tail subtended to the naked eye an angle of at least 10 degrees.

September 18.

G.

OBSERVATIONS OF THE COMET 1858 V.

By JAMES FERGUSON.

[Communicated by Commander MAURY.—Corrected for refraction.]

Date.	Washington M.T.	No. Comp.	Comparison-Star.	$\angle - *$		$\angle$'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 July 9	9 ^h 17 ^m 48.8 ^s	2	B. Z. 349,71	— 2 14.45	— 6 41.39	9 35 50.41	+27 27 52.94
" 10	8 56 59.9	6	70	— 1 16.11	— 8 42.18	9 36 27.22	27 33 12.13
" "	"	6	71	— 2 7.61	— 1 22.09	9 36 27.57	27 33 14.91
" 11	9 0 21.2	10	70	— 0 37.67	— 3 7.35	9 37 5.75	27 38 47.70
" 14	8 45 20.9	3	70	+ 1 23.61	+ 13 36.66	9 39 7.28	27 55 34.74
" 15	8 49 13.2	10	72	+ 1 5.78	+ 12 27.10	9 39 49.81	28 1 15.22
" 16	8 38 3.2	4	72	+ 1 48.91	+ 18 9.25	9 40 32.96	28 6 57.68
" 17	8 39 36.1	3	77	— 4 33.00	— 8 48.81	9 41 17.45	28 12 52.37
" 21	8 37 54.1	5	77	— 1 26.40	+ 14 18.13	9 44 24.46	28 36 4.51
" 24	8 42 52.0	3	81	— 1 51.22	+ 8 3.01	9 46 55.41	28 54 22.93
" 25	8 35 0.3	6	81	— 0 59.28	+ 14 13.18	9 47 47.46	29 0 34.48
" 27	8 36 0.7	6	B. Z. 406,52	+ 0 30.22	— 0 52.13	9 49 35.00	29 13 9.83
" 28	8 29 57.1	3	53	+ 0 18.33	+ 4 11.34	9 50 29.89	29 19 41.07
" 29	8 29 25.7	6	* 1	— 0 23.41	— 1 9.86	9 51.4	29 26.2
" "	8 36 58.3	4	* 2	— 1 42.15	— 1 56.02	9 51.4	29 26.2
Aug. 4	8 23 15.1	5	B. Z. 406,63	— 1 29.93	— 5 6.86	9 57 30.66	30 7 6.33
" 7	8 16 58.8	4	63	+ 1 46.68	+ 16 27.67	10 0 48.29	30 28 56.46
" 8	8 8 54.5	1	68	— 1 40.14	— 14 8.90	10 1 57.20	30 36 34.81
" 10	8 10 31.6	1	68	+ 0 10.94	+ 1 12.12	10 4 18.92	30 52 4.00
" 13	8 14 58.3.	2	* 3	— 1 50.60	+ 7 47.86	10 8.0	31 16.4
" 15	8 4 3.6	4	B. Z. 501,35	— 4 15.45	— 0 10.95	10 10 43.40	31 32 58.73
" 16	7 54 34.2	5	35	— 2 54.59	+ 8 23.94	10 12 4.66	31 41 38.59
" 17	7 41 44.5	1	35	— 1 34.46	+ 17 3.07	10 13 27.89	31 50 18.91
" 19	7 47 11.6	2	B. A. C. 3490	+ 9 21.18	— 1 39.92	10 16 21.26	32 8 34.53
" 22	7 39 20.9	2	B. Z. 501,51	— 6 30.56	+ 6 5.99	10 20 58.66	32 36 39.66
" 23	7 47 20.7	3	B. A. C. 3610	— 8 7.61	+ 3 40.92	10 22 37.36	32 46 25.16
" 24	7 38 5.2	5	B. A. C. 3602	+ 0 29.23	— 9 58.63	10 24 17.59	32 56 17.41
" 25	7 35 41.5	8	"	+ 2 12.35	— 0 3.24	10 26 1.14	33 6 18.21
" 31	7 35 42.3	1	(* 4)	+ 3 24.74	— 1 4.17	10 38.4	34 9.1
Sept. 3	7 26 0.1	9	B. A. C. 3728	— 0 57.04	— 17 57.05	10 44 25.34	34 10 32.71
" 5	7 25 36.6	8	B. A. C. 3736	+ 2 20.38	+ 14 1.00	10 49 26.76	35 1 29.83
" 6	7 17 46.2	2	"	+ 4 59.00	+ 21 25.08	10 52 5.63	35 11 57.33
" 7	7 3 59.1	2	B. Z. 499,144	— 5 53.83	— 7 4.04	10 54 54.58	+35 21 46.79

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α			δ			Authority.
		ⁿ	^m	^s	^o	[']	["]	
B. Z. 319.70	8	9	37	49.16	+27	41	20.89	The places are from BESSEL's Zones and the British Association Catalogues.
71	9	9	38	40.69	27	31	1.27	
72	9	9	38	49.50	27	48	10.57	
77	8	9	45	56.21	28	21	7.71	
81	8	9	48	51.95	28	45	41.31	
406.52	7	9	49	10.44	29	13	27.86	
53	9	9	50	17.03	29	11	53.41	
63	8	9	57	6.19	30	11	42.21	
68	8	10	3	43.10	30	50	16.86	
501.35	7	10	15	4.27	31	32	35.88	
501.51	7	10	27	34.26	32	29	57.45	
499.144	8	11	0	53.59	35	28	20.97	
* 1	9	9	51	52	29	26	47	
* 2	7	9	53	11	29	27	34	
* 3	9	10	9	57	31	8	1	
B. A. C. 3490	7	10	7	2.60	32	9	42.77	
B. A. C. 3640	4	10	30	50.07	32	42	8.11	
B. A. C. 3602	5	10	23	51.10	33	5	48.64	
* 4	8	10	35.1		34	9.9		
B. A. C. 3728	4	10	15	28.25	34	58	7.34	
B. A. C. 3736	7	10	17	10.87	+34	46	48.35	

The stars * 1 and * 2 were supposed, at the time of comparison, to be B. Z. 406.55 and 501.29. On the evening of the 17th August, four comparisons were lost by fault of the chronograph.

PLANET-CIRCULAR.

A NEW ASTEROID was discovered with the Clark comet-seeker on the night of Friday, September 10, by Mr. GEORGE SEARLE, Assistant at this Observatory.

The apparent position was roughly estimated as being :

Albany M.T.	α	δ
Sept. 10 10 ^h 30 ^m	0 ^h 49 ^m .2	+3° 22'

On the 11th and 12th September its positions, as approximately determined with the ring-micrometer of the comet-seeker, were as follows — (the declinations being very rough) :

Albany M.T.	α	δ
Sept. 11 11 ^h 53 ^m 10 ^s	0 ^h 48 ^m 33 ^s .7	+3° 22'.0
12 11 13 0	0 47 53.4	+3 20.2

These positions depend upon the 7^M star Piazzi O, 216 (B.A.C. 243), of which the adopted apparent place for Sep. 11 is

* α	* δ
0 ^h 46 ^m 3 ^s .8	+3° 19' 17".8

The planet is of about the eleventh magnitude, and will soon be in opposition.

The facilities for determining the place properly at this Observatory are not yet available, owing to serious and unexpected obstacles. The large meridian-circle is, however, already in position and approximate adjustment ; and I trust that, within a few weeks, all obstacles will have been surmounted and the instrument brought into use.

DUDLEY OBSERVATORY, 1858 September 13.

B. A. GOULD JR.

FIFTY-FOURTH ASTEROID.

THIS Planet has been observed by Mr. FERGUSON at Washington and Mr. WATSON at Ann-Arbor, who have communicated the following observations :

Washington M.T.		No. Comp.	*	$\lambda\alpha$	$\lambda\delta$	α	δ
Sept. 13	8 ^h 45 ^m 39.05	10	B.A.C. 243	+1 ^m 8 ^s 29	-1 12 02	0 ^h 47 ^m 13.04	+3° 18' 8".38
12	9 56 25.45	11	"	-1 12.05	-4 46.57	0 41 52.73	+3 14 33.97
Ann-Arbor M.T.							
Sept. 13	11 47 8.6	8	"	+1 1.71	-1 20.1	0 47 6.5	+3 17 59.8
"	12 34 11.2	5	"	+1 0.12	-1 22.4	0 47 5.0	+3 17 57.5
14	12 12 16.7	10	"	+0 15.80	-2 27.8	0 46 20.6	+3 16 52.1

Adopted Mean Place for 1860.0 of Comparison-Star.

*	α	δ
B.A.C. 243	0 ^h 46 ^m 7 ^s .31	+3° 19' 33".81

Mr. SEARLE has also obtained with the comet-seeker the following approximate places, in addition to those given in the Planet-Circular :

Albany M. T.		*	$\lambda\alpha$	$\lambda\delta$	α	δ
Sept. 13	10 ^h 3 ^m 26 ^s	B.A.C. 243	+1 ^m 6 ^s .8	-1 0	0 ^h 47 ^m 11 ^s .6	+3° 18'.3
14	11 ^h 1 ^m 53 ^s	"	+0 ^m 20 ^s .05	-2.8	0 ^h 46 ^m 24 ^s .8	+3° 16'.5
17	14 ^h 0 ^m 42 ^s	"	-2 ^m 7 ^s .60	-6.0	0 ^h 43 ^m 57 ^s .3	+3° 13'.3 ;

and from circular elements representing the places on the 11th, 14th and 17th, he has computed a finding-ephemeris for Washington mean midnight and the mean equinox 1858.0, as follows :

Date 1858	α	δ	Date 1858	α	δ
Sept. 11	0 ^h 48 ^m 30 ^s	+3° 19'.9	Sept. 27	0 ^h 35 ^m 21 ^s	+2° 57'.3
13	0 47 3	3 18.0	29	0 33 33	2 53.9
15	0 45 32	3 15.8	Oct. 1	0 31 45	2 50.5
17	0 43 57	3 13.2	3	0 29 56	2 47.1
19	0 42 19	3 10.3	5	0 28 8	2 43.8
21	0 40 37	3 7.3	7	0 26 22	2 40.5
23	0 38 53	3 4.1	9	0 24 37	2 37.3
25	0 37 7	+3 0.7	11	0 22 51	+2 31.2

This ephemeris will doubtless serve to identify the planet after the full moon.

G.

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PLANET-CIRCULAR.

FIFTY-FOURTH ASTEROID.

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THE ASTRONOMICAL JOURNAL. No. 117.

VOL. V.

ALBANY, 1858, OCTOBER 16.

NO. 21.

FROM A LETTER OF MR. SCHUBERT TO PROFESSOR WINLOCK.

Berlin, 1858 September 9.

I HASTEN to inform you of a very interesting discovery I have made in these days. Having computed a new orbit of *Daphne* from the observations in 1857, I found that with these new elements the observations in 1856 can not be represented : they give the right-ascension too great by 16° , and the declination too small by 7° . From this already I felt sure that I had thus discovered a new planet, and that *Daphne* had not been found and observed in 1857. For farther con-

firmation of the fact, I am now computing an orbit from the observations in 1856 and 1857 (a very troublesome task, on account of the great difference between the intervals). I have to make some more approximations to *P* and *Q*, in order to get out every thing as accurately as possible. But in order to secure the priority to me and to the Almanac-office, I made a preliminary conclusion, and found from 1856 June 2, 1857 Sept. 16 and Sept. 30, the following curious elements :

$$\begin{array}{l} 1856 \text{ June } 2.1 \text{ Berlin M.T.} \\ M = 343^{\circ} 20' \\ \pi = 211 \ 53 \\ \Omega = 180 \ 43 \} \text{ Mean Equinox 1858.0} \\ i = 22 \ 36 \\ q = 31 \ 46 \\ \mu = 479''.1 \\ \log a = 0.5797 \end{array}$$

These elements represent the fundamental planes to seconds ; but for the independent observation of Sept. 23, they leave in geocentric longitude and latitude

C.—O.

$$\delta\alpha = +2.5, \quad \delta\beta = -1.0;$$

therefore there is no doubt of the diversity of the two planets.

As soon as I have finished the work on this highly interesting subject, I will send you all the results in a report.

Daphne must be discovered anew : therefore instead of the work on *Daphne*, I will continue the work on this new planet. It will be in opposition by the end of this or the beginning of next year, and I intend to compute an ephemeris for this opposition. In the course of October you will receive the work on this planet, together with the approximate ephemerides of *Leucothea* and *Psyche* for 1860.

E. SCHUBERT.

COMPARISON OF SOME OBSERVATIONS OF CERES, IRIS, EUNOMIA, MELPOMENE AND THALIA, IN 1858.

BY E. SCHUBERT.

WHEN in the month of January 1853 I left Cambridge for Berlin on account of my ill health at that time, Captain DAVIS charged me with the determination anew of the orbits of *Ceres*, *Eunomia*, *Melpomene* and *Thalia*, and with the continuation of the computations on *Iris* (the theory of which planet I had already determined in Berlin for 1848 January 1.0). The manner in which I have done that work can be followed up step for step in this Journal. Ephemerides of all

five for 1858 and 1859 have been computed and published : all five have been observed already this year ; and in order to know what precision has been obtained in the theory, I have compared the observations at hand. The observations of *Ceres*, *Iris* and *Eunomia* are Berlin meridian-observations ; those of *Melpomene* and *Thalia* are Washington and Berlin refractor-observations.

CERES.

		C.—O.	
		$\Delta\alpha$	$\Delta\delta$
June 4		—0.50	+6.1
6		0.38	6.6
8		0.31	5.0
9		0.36	8.5
15		0.05	5.2
16		0.67	5.0
21		—0.61	+7.0
Mean		—0.37	+6.2

IRIS.

		$\Delta\alpha$	$\Delta\delta$
July 14		+2.93	+15.7
18		3.23	16.1
19		3.14	13.8
21		3.11	14.9
26		+3.35	+14.7
Mean		+3.17	+15.0

EUNOMIA.

		$\Delta\alpha$	$\Delta\delta$
February 10		—0.04	—0.8
11		+0.15	0.1
12		0.23	1.3
20		0.09	1.1
22		0.17	7.0
23		0.23	5.4
25		0.15	2.9
26		0.01	2.5
March 4		+0.18	—3.3
Mean		+0.17	—2.7

MELPOMENE.

		C.—O.	
		$\Delta\alpha$	$\Delta\delta$
March 10		+0.20	—1.5 Washington.
11		+0.32	—0.5 "
12		(—1.72)	+1.5 "
18		+0.16	—9.2 "
24		0.78	—0.4 "
26		0.66	—3.6 "
28		0.30	—10.5 Berlin.
29		0.36	+2.0 Washington.
30		+0.25	—6.8 Berlin.
Mean		+0.38	—3.2

THILIA.

		$\Delta\alpha$	$\Delta\delta$
April 13		+0.42	+2.0 Berlin.
14		0.21	+1.0 "
19		0.26	—0.4 "
20		+0.28	—0.3 "
Mean		+0.29	+0.6

From this comparison, it appears that the theories of the orbits are perfect. Since 1848, I have made no correction of the elements of *Iris* : therefore the above +3.17 and +15.0 (as accumulated in 10 years) are small quantities).

In addition to these five asteroids, Professor WINLOCK has charged me also with the work on *Psyche*, *Pomona*, *Polymnia*, *Leucothea* and *Daphne*, which I have at present under preparatory treatment.

May other governments follow the example thus set by that of the United States, by sustaining special computers for asteroids ; and although the number of them is great, all may be mastered easily.

ELEMENTS AND EPHEMERIS OF THE FIFTY-FOURTH ASTEROID.

BY T. H. SAFFORD AND S. NEWCOMB.

THE following elements are deduced from observations made at Washington, September 13, and at Cambridge, September 20 and 27 :

Epoch September 27.31960 Washington M.T.

$$\begin{aligned} M &= 319^{\circ} 1' 36.4 \\ \pi &= 21 46 46.6 \\ \Omega &= 10 50 51.0 \\ \varphi &= 7 41 19.4 \\ i &= 7 36 47.4 \\ \mu &= 12 46.076 \\ \log a &= 0.443822 \end{aligned}$$

The Cambridge observations were kindly furnished by Mr. BOND.

Comparison with the middle place gave

$$\begin{aligned} &C.—O. \\ \Delta\alpha &= -1''.0, \quad \Delta\delta = -0''.4. \end{aligned}$$

From these elements the following short ephemeris has been derived :

	0 ^h Washington.	α	δ	$\log \Delta$
Sept. 30		0 ^h 33 ^m 17 ^s	+2° 52.3	0.1506
Oct. 2		31 17	48.7	
4		29 19	45.2	
6		27 25	41.7	0.1514
8		25 31	38.2	
10		23 47	34.9	
12		22 3	31.8	0.1551
14		20 22	29.0	
16		18 46	26.5	
18		17 13	24.3	0.1617
20		15 44	22.5	
22		14 20	21.1	
24		13 1	20.0	0.1706
26		11 48	19.3	
28		10 40	19.2	
30		0 9 39	+2 19.8	0.1819

The values of $\log \Delta$ for the times of observation are :

Sept. 13, 0.1634 ; Sep. 20, 0.1554 ; Sep. 27, 0.1512.

EPHEMERIS OF LEUCOTHEA FOR THE OPPOSITION IN 1858.

BY E. SCHUBERT.

[Communicated by Professor WINLOCK, Superintendent American Ephemeris.]

Washington Mean Noon.

1858	(35) α	(35) δ	$\log \Delta$	$\log r$	1858	(35) α	(35) δ	$\log \Delta$	$\log r$
	^h ^m ^s	[°] ['] ["]				^h ^m ^s	[°] ['] ["]		
Oct 27	4 42 16.75	+32 19 19.7	0.407064	0.528266	8 29	4 14 25.92	+32 27 40.1	0.370592	
28	41 43.22	21 13.5	405295		30	13 25.75	25 57.5	370345	0.520965
29	41 8.27	23 2.7	403557	527857	Dec. 1	12 25.68	24 8.2	370154	
30	40 31.92	24 47.0	401852		2	11 25.76	22 12.4	370020	520512
31	39 51.20	26 26.1	400178	527445	3	10 26.06	20 10.4	369942	
Nov. 1	39 15.12	27 59.7	398540		4	9 26.66	18 1.5	369921	520057
2	38 34.70	29 27.9	396938	527031	5	8 27.60	15 46.9	369956	
3	37 52.99	30 50.5	395372		6	7 28.94	13 26.3	370047	519600
4	37 10.02	32 7.2	393844	526614	7	6 30.76	10 59.9	370191	
5	36 25.80	33 17.9	392353		8	5 33.11	8 28.0	370395	519140
6	35 40.38	34 22.5	390902	526191	9	4 36.01	5 50.9	370652	
7	34 53.80	35 20.9	389491		10	3 39.63	3 8.9	370965	518678
8	34 6.08	36 12.8	388123	525772	11	2 43.95	32 0 22.2	371332	
9	33 17.27	36 58.3	386796		12	1 49.04	31 57 30.9	371752	518214
10	32 27.40	37 37.3	385514	525348	13	0 54.93	54 35.3	372225	
11	31 36.54	38 9.6	384277		14	1 0 1.70	51 35.6	372749	517746
12	30 44.71	38 35.1	383086	524921	15	3 59 9.36	48 32.1	373325	
13	29 51.97	38 53.7	381942		16	58 17.96	45 25.0	373951	517276
14	28 58.35	39 5.4	380846	524491	17	57 27.59	42 14.6	374627	
15	28 3.94	39 10.2	379799		18	56 38.26	39 1.2	375352	516804
16	27 8.76	39 7.8	378801	524059	19	55 50.03	35 41.9	376126	
17	26 12.87	38 58.2	377852		20	55 2.92	32 26.1	376947	516330
18	25 16.32	38 41.3	376954	523625	21	54 16.98	29 5.1	377815	
19	24 19.16	38 17.3	376107		22	53 32.23	25 42.2	378728	515852
20	23 21.43	37 46.1	375313	523188	23	52 48.71	22 47.8	379687	
21	22 23.17	37 7.5	374574		24	52 6.46	18 51.9	380689	515373
22	21 24.47	36 21.7	373883	522748	25	51 25.51	15 24.9	381733	
23	20 25.38	35 28.5	373248		26	50 45.88	11 56.9	382818	514891
24	19 25.95	34 28.2	372668	522306	27	50 7.61	8 28.3	383945	
25	18 26.24	33 20.7	372142		28	49 30.73	4 59.3	385112	514406
26	17 26.34	32 6.1	371671	521861	29	48 55.25	31 1 30.2	386317	
27	16 26.27	30 14.5	371256		30	3 48 24.18	+30 58 1.1	0.387559	0.513918
28	4 15 26.12	+32 29 15.8	0.370896	0.521414					

8 1858 November 29^d 7^h 36^m.5 Washington M.T. Intensity of light = 0.58.

This ephemeris is deduced from the osculating elements :

1858 December 1.0 Washington M.T.

 $M = 250^{\circ} 57' 7.4$ $\pi = 198 37 22.9$ $\Omega = 356 9 56.2$ $i = 8 12 3.7$ $q = 12 51 22.6$ $\mu = 688 .0153$ $\log \mu = 2.837598$ $\log a = 0.474940$

} Mean Equinox Epoch.

NOTE ON THE EXTENSION OF LAGRANGE'S THEOREM FOR THE DEVELOPMENT OF FUNCTIONS.

BY PROFESSOR PEIRCE.

THE following ready and simple application of an ingenious principle, introduced by HANSEN into his new method of perturbations, affords an important extension of LAGRANGE'S theorem, to the case in which both the functions introduced into the theorem depend upon both the variables involved in it.

If the variables x and t are connected by the equation

$$x - t = f(x, t),$$

any other function of these two variables may be developed into the series

$$F(x, t) = F(t, t) + \sum_0^{\infty} \frac{D_x^i [\{f(x, t)\}^{i+1} D_x F(x, t)]}{(i+1)!} [x=t]$$

in which the annexed $[x=t]$ denotes that t is to be substituted for x in the second member, after the differentiation.

OBSERVATIONS, ELEMENTS AND EPHEMERIS OF THE FIFTY-FOURTH ASTEROID.

BY JAMES C. WATSON.

THE observations are the following :

Date.	Ann-Arbor M.T.	No. Comp.	Comparison-Star.	Planet — Star		Apparent	
				$A\alpha$	$A\delta$	α	δ
1858 Sept. 13	^h 11 ^m 47 ^s 10.4	8	B. A. C. 243	^m + 1 1.71	[°] — 1 18.3	^h 0 47 ^m 6.32	[°] + 3 18 2.3
13	12 34 11.7	5	"	+ 1 0.12	— 1 20.6	0 47 4.73	3 18 0.0
14	12 12 8.4	10	"	+ 0 15.80	— 2 24.6	0 46 20.42	3 16 55.9
15	10 15 4.4	10	"	— 0 26.46	— 3 32.0	0 45 38.17	3 15 48.7
16	10 53 10.9	10	"	— 1 14.78	— 4 47.2	0 44 49.86	3 14 33.5
17	11 7 14.3	10	Bessel's Z. 116,65	— 0 39.45	— 4 28.1	0 44 1.21	3 13 11.0
17	11 7 14.3	10	B. A. C. 243	— 2 3.52	— 6 9.1	0 44 1.13	3 13 11.6
18	10 38 51.3	10	Bessel's Z. 116,65	— 1 27.31	— 5 46.2	0 43 13.36	3 11 52.9
19	12 15 30.0	10	" 116,65	— 2 20.70	— 7 17.8	0 42 19.98	+ 3 10 21.3

Adopted Mean Places 1858.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
B. A. C. 243	7	^h 0 46 ^m 0.88	[°] + 3 18 54.6	Meridian-Circle—Professor Brünnow.
Bessel's Z. 116	8	0 44 36.90	+ 3 17 13.0	Mean of Bessel & Eq. from B.A.C. 243.

Professor BRÜNNOW observed the following position of the planet with the Meridian-Circle :

Ann-Arbor M.T.	α	δ
1858 September 16 13 ^h 1 ^m 7 ^s .2	0 ^h 44 ^m 45 ^s .47	+3° 11' 26".7

From the observations on September, 13, 16 and 19, the following elements have been computed :

Epoch = 1858 September 19.5 Washington M.T.

$$\begin{aligned} M &= 321^{\circ} 25' 47.1 \\ \pi &= 56 \quad 5 \quad 5.5 \\ \Omega &= 10 \quad 37 \quad 15.4 \\ i &= 8 \quad 31 \quad 58.7 \\ q &= 8 \quad 26 \quad 33.2 \\ \log a &= 0.450555 \\ \log \mu &= 2.874174 \\ \mu &= 748''.470 \end{aligned} \quad \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} \text{Mean Equinox 1858.0}$$

These elements give the following ephemeris, referred to the mean equinox 1858.0 :

EPHEMERIS FOR WASHINGTON MEAN MIDNIGHT.

1858	α	δ	$\log \Delta$	$\log r$	1858	α	δ	$\log \Delta$	$\log r$
	^h ^m ^s	[°] ['] ["]				^h ^m ^s	[°] ['] ["]		
Sept. 10	0 49 12	+ 3 20.6	0.20060	0.40133	Oct. 9	0 21 11	+ 2 35.8	0.18010	
11	48 30	3 19.7	0.19892		10	23 17	2 31.2	0.18085	0.39839
12	47 48	3 18.7	0.19731	0.40392	11	22 24	2 32.7	0.18137	
13	47 4	3 17.7	0.19576		12	21 31	2 31.2	0.18196	0.39802
14	46 19	3 16.6	0.19427	0.40351	13	20 39	2 29.8	0.18263	
15	45 33	3 15.4	0.19285		14	19 48	2 28.4	0.18338	0.39765
16	44 46	3 14.2	0.19149	0.40310	15	18 58	2 27.1	0.18420	
17	43 57	3 12.9	0.19020		16	18 9	2 25.8	0.18509	0.39728
18	43 8	3 11.6	0.18897	0.40269	17	17 21	2 24.6	0.18605	
19	42 18	3 10.2	0.18781		18	16 34	2 23.6	0.18708	0.39691
20	41 27	3 8.7	0.18672	0.40228	19	15 47	2 22.7	0.18817	
21	40 36	3 7.2	0.18570		20	15 2	2 21.8	0.18933	0.39655
22	39 44	3 5.6	0.18476	0.40188	21	14 18	2 21.0	0.19056	
23	38 51	3 4.0	0.18389		22	13 35	2 20.3	0.19185	0.39619
24	37 58	3 2.3	0.18309	0.40148	23	12 54	2 19.8	0.19320	
25	37 4	3 0.6	0.18236		24	12 11	2 19.3	0.19461	0.39584
26	36 9	2 58.8	0.18171	0.40108	25	11 35	2 18.9	0.19608	
27	35 14	2 57.0	0.18114		26	10 57	2 18.6	0.19761	0.39549
28	34 19	2 55.2	0.18064	0.40069	27	10 21	2 18.5	0.19920	
29	33 24	2 53.4	0.18023		28	9 46	2 18.4	0.20084	0.39515
30	32 29	2 51.6	0.17989	0.40030	29	9 13	2 18.5	0.20254	
Oct. 1	31 33	2 49.7	0.17963		30	8 41	2 18.6	0.20428	0.39481
2	30 37	2 47.8	0.17945	0.39991	31	8 11	2 18.9	0.20606	
3	29 41	2 46.0	0.17935		Nov. 1	7 42	2 19.4	0.20789	0.39447
4	28 45	2 44.2	0.17932	0.39953	2	7 15	2 20.0	0.20978	
5	27 49	2 42.4	0.17937		3	6 49	2 20.7	0.21171	0.39413
6	26 54	2 40.7	0.17952	0.39915	4	6 25	2 21.5	0.21370	
7	25 59	2 39.0	0.17974		5	6 3	2 22.4	0.21574	0.39379
8	0 25 5	+ 2 37.4	0.18003	0.39877	6	0 5 43	+ 2 23.4	0.21782	

The observations upon which the above elements are based were very satisfactory ; and the ephemeris may be expected to represent the places of the planet, for a few weeks at least, with considerable accuracy.

Ann Arbor, 1858 September 23.

ELLIPTIC ELEMENTS OF THE FIFTH COMET OF 1858.

BY JAMES C. WATSON.

THE parabolic elements computed from normal places on June 11, July 13 and August 14, and published in the *Astr. Journal*, N° 116, represent the entire series of observations from the date of the discovery of the comet until the middle of September in a most satisfactory manner. The discordance, however, between the places computed from those elements and the observed places has now become considerable ; and I have, therefore, computed from normal places for June 11, August 13 and September 25, the following system of elliptic elements :

$$\begin{aligned}
 T &= 1858 \text{ Sept. } 29.736355 \text{ Washington M.T.} \\
 \pi &= 36^{\circ} 13' 6.2 \\
 Q_0 &= 165 19 11.8 \\
 i &= 63 1 27.9 \\
 q &= 85 24 22.6 \\
 e &= 0.996787 \\
 \log a &= 2.255279 \\
 \log q &= 9.762303
 \end{aligned}
 \left. \begin{array}{l} \\ \\ \\ \\ \\ \\ \end{array} \right\} \text{Mean Equinox 1858.0}$$

Motion Retrograde.

The period of revolution corresponding to these elements is 2415 years ; and, compared with the middle place, they give the following residual errors :

$$\Delta \cos \beta = -12''.8, \quad \Delta \beta = +3''.7.$$

These errors are not very large ; and the above system of elliptic elements may, therefore, be expected to represent the observations of the comet during the remaining period of its visibility in the northern hemisphere at least, with considerable precision. It is possible, moreover, that the tail of the comet may produce anomalies in its motion ; and since the observations will embrace a very great interval of time both before and after its perihelion passage, we may determine, when the entire series of observations shall be published, the effect and nature of such irregularities, should they really be found to exist. The result of a complete discussion of this subject may be to furnish ultimately a criterion for accounting

for the non-appearance of DE VICO'S comet in 1855 as computed from the observations made in 1844.

The daily motion of the comet, both in right ascension and declination, is now very great, and will remain so during the remaining period of its visibility; and, since, in order to compare the observations with the foregoing elements, it will be expedient to compute an ephemeris for an epoch as near the time of observation as possible, I have not computed an ephemeris as usual for a given meridian, but append simply the expression for the rectangular equatorial co-ordinates of

the comet referred to the center of the sun. They are the following, and are referred also to the mean equinox 1858.0 :

$$x = r(9.988632) \sin(45^\circ 52' 12.5'' + v)$$

$$y = r(9.375361) \sin(207^\circ 29' 16.4'' + v)$$

$$z = r(9.998813) \sin(134^\circ 51' 21.7'' + v)$$

$$\log(1 + e) = 0.062635.$$

Before the perihelion passage, v is considered negative.

Ann Arbor, 1858 Oct. 2.

OBSERVATIONS OF COMETS 1858 V AND 1858 VI, AND OF ENCKE'S COMET.

MADE WITH THE FILAR MICROMETER OF THE WASHINGTON EQUATORIAL,

By JAMES FERGUSON.

[Communicated by Commander MARRY.—Corrected for refraction.]

COMET 1858 V.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	— *		Comet's apparent	
				α	δ	α	δ
	h m s			m s	° ' "	h m s	° ' "
1858 Sept. 7	7 3 59.1	2	B. Z. 499,144	— 5 53.97	— 7 6.00	10 51 51.58	+35 21 46.79
9	7 16 26.6	10	" 499,111	+ 0 7.71	+12 35.64	11 0 56.28	35 41 28.04
10	7 11 46.6	14	" 499,118	— 0 9.27	+ 3 57.94	11 4 9.64	35 50 31.99
12	7 10 2.7	14	" 358, 9	+ 0 3.39	— 9 2.99	11 11 12.63	36 6 39.14
13	7 5 52.8	5	" 358, 9	+ 3 50.57	— 2 19.91	11 14 59.92	36 13 22.00
19	7 1 19.1	4	" 359, 32	+ 4 58.83	—18 3.14	11 43 8.67	36 22 37.48
*20	6 57 3.5	8	" 358, 29	+ 0 14.22	+ 8 2.91	11 48 55.24	36 15 44.59
"	7 5 11.6	11	" 358, 30	— 0 1.70	+ 1 12.72	12 48 57.57	36 15 48.07
26	7 21 46.7	6	" 409, 16	+ 2 48.60	+ 5 30.85	12 33 39.79	33 54 16.83
28	6 52 1.3	6	" 408, 84	— 2 21.50	—22 20.57	12 51 19.02	32 9 51.82
29	6 50 6.1	5	" 168, 77	— 1 1.70	— 0 29.99	13 1 21.29	30 59 26.35
30	6 41 52.6	3	* 8	+ 1 36.88	— 9 29.82	13 10.1	29 42.3
"	7 30 46.3	2	* 6	— 0 8.80	+16 42.05	13 10.1	29 42.0
Oct. 1	6 53 32.3	5	B. Z. 464,125	+ 1 9.70	— 2 13.51	13 23 56.86	27 54 8.10
2	6 56 46.3	7	" 462, 49	— 3 5.99	+11 38.96	13 34 28.82	26 11 33.20
3	7 26 54.5	3	" 412,139	+ 0 20.86	+ 0 12.27	13 16 34.17	24 2 42.24
5	6 51 14.0	5	* 7	— 0 27.58	— 0 3.67	14 11.5	+18 59.0

* Subsequent to September 20, the observations were made under unfavorable circumstances, and are probably less reliable than the others.

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
		h m s	° ' "	
B. Z. 499,144	8	11 0 53.60	+35 28 20.97	Bessel's Zones.
" 499,118	8	11 4 23.91	35 16 2.92	
" 358, 9	7	11 11 14.30	36 15 11.08	
" 359, 32	7	11 38 14.62	36 40 9.10	
" 358, 29	7	11 18 15.63	36 7 9.55	
" 358, 30	7	11 19 3.98	36 13 33.22	
" 409, 16	8	12 30 55.66	33 18 17.12	
" 408, 84	7	12 53 11.96	32 31 7.23	
" 168, 77	8	13 2 27.33	30 59 28.51	Bessel's Zones.
* 5	8	13 9	29 51	
* 6	9	13 11	29 26	
B. Z. 464,125	8	13 22 51.41	27 56 24.45	
" 462, 49	9	13 37 39.08	25 59 28.17	
" 412,139	9	13 46 17.85	+24 1 34.52	

COMET 1858 VI.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	☾ - *		☾'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 Sep. 12	^h 11 ^m 31 ^s 57.2	11	* 1	— 0 ^m 0.75	+ 3 ^s 53.80	^h 4 ^m 10 ^s 56.09	+ 46 [°] 47 ['] 3.82
13	10 8 5.7	2	* 2	— 0 17.17	— 1 2.33	4 5 12.56	+ 47 3 41.17
17	10 37 55.7	4	* 3	+ 0 27.54	+ 5 31.78	3 34 28.81	+ 48 9 32.03

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
* 1	8.9	4 11 1.73	+ 46 43 20.96	Washington Equatorial.
* 2	8.9	4 5 34.57	+ 47 7 54.25	"
* 3	9	3 34 5.66	+ 48 4 10.36	"

ENCKE'S COMET.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	☾ - *		☾'s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 Sep. 9	^h 13 ^m 55 ^s 23.1	7	B. A. C. 2563	+ 1 ^m 8.04	+ 4 ^s 33.74	^h 7 ^m 39 ^s 31.03	+ 33 [°] 50 ['] 12.13
12	13 53 39.1	2	B. Z. 401.82	— 0 58.20	— 4 13.48	8 5 56.52	+ 32 32 2.65

Adopted Mean Places for 1860.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
B. A. C. 2563	5.5	7 38 28.29	+ 33 45 21.95	British Association Catalogue.
B. Z. 401.82	8	8 6 59.94	+ 32 35 56.87	Bessel's Zones.

OBSERVATION ON THE FIFTH COMET OF 1858.

BY WILLIAM C. TAYLOR.

THE brilliant comet now visible presents one interesting appearance which I do not remember to have seen particularly noticed in any description of similar bodies. This is *the shadow of the nucleus* projected through the tail.

Doubtless all our observers have had their attention attracted to this phenomenon, as it is now quite distinct. The

object of this communication, therefore, is merely to suggest that the degrees of deflection, suffered respectively by the tail and by the shadow within it, may furnish a convenient means of comparing the velocity with which the tail is emitted from the nucleus, and the velocity of light, as indicated by this shadow.

Philadelphia, 1858 September 29.

NEW ASTEROID.

ANOTHER asteroid was discovered on September 10 by Mr. GOLDSCHMIDT at Paris, who communicates the following observations :

	Paris M.T.	α	δ
1858 Sep. 11	10 ^h 55 ^m	21 ^h 38 ^m 42 ^s	— 6° 6' 0"
12	7 50	21 38 8	
13	8 40		— 6 5 56

A meridian observation at the Paris Observatory gives

1858.	α	δ
Sep. 13	21 ^h 37 ^m 27 ^s .8	— 6° 3 28'.9

This asteroid of Mr. GOLDSCHMIDT's having been detected on the same evening as that of Mr. SEARLE, the order of numeration must depend upon the absolute time of the first published observation, which is as yet unknown to me.

G.

NEW WORK.

The U.S. Astronomical Expedition to the Southern Hemisphere, during the years 1849-52. Vol. III : Observations to determine the Solar Parallax, by Lieut. J. M. GILLISS, LL.D., Superintendent. Washington, 1856.

THIS volume, though bearing the date of the year in which the observations were printed, has only been issued a few weeks. It contains 332 pages of observations of *Mars* and *Venus* during two oppositions of the former and inferior conjunctions of the latter, made at Santiago by Lieut. GILLISS or under his superintendence. These series comprise both micrometric comparisons with the equatorial, and absolute determinations with the meridian circle. These are followed by 69 pages from the Washington Observatory, containing a description of the equatorial and a series of micrometric observations by Mr. FERGUSON of each of the four oppositions or conjunctions. A portion contributed by Mr. BOND of the Cambridge Observatory contains 43 pages of observations of *Mars* during the opposition of 1849-50, chiefly micrometric determinations of right-ascension. Finally, Mr. MACLEAR, of the Royal Observatory at the Cape of Good Hope, has furnished an extensive series of micrometer-comparisons with the preselected stars, during the first opposition of *Mars*.

These 492 pages of observations and accompanying remarks are preceded by introductory remarks upon the origin and operations of the expedition, with a description of the instruments and method of observation employed, by Lieut. GILLISS; and by a detailed discussion of the entire mass of observations by the Editor of this Journal. This discussion occupies 264 pages.

The plan of the expedition contemplated micrometric comparisons of the limbs of the planets, with stars previously selected by Lieut. GILLISS for the purpose, simultaneously made in the northern and southern hemispheres; but the extremely small number of northern observations precluded all hope of attaining any valuable addition to our knowledge of the Solar Parallax by this method.

In the earnest desire that so extended and costly a series of careful observations should not prove futile for the attainment of the desired end, a method of discussion has been employed, which, though entailing an inordinate amount of toil, seemed to afford the only adequate means of rendering the observations serviceable for the fulfilment of their design. The method may be briefly described.

A catalogue of the comparison-stars having been prepared, their declinations were obtained from a thorough examination of all the available sources, and from the combination by weights of the positions as given by the several authorities. Regard being had to the existence of any possible proper motion, the positions thus obtained were referred to the mean equinox of the beginning of the year in which the comparisons

were made, and a Final List of Comparison-Stars thus constructed, containing not only the declinations of each star, but the relative value of the determination.

The complete reduction of all the observations was then repeated, and the several comparisons with each star consolidated with care into a single observation, of which the weight was determined, and which was subsequently treated like an absolute determination of place, and even combined with meridian-observations. Each of the four series (viz. the two *Mars*-oppositions and the two *Venus*-conjunctions) was treated independently, and the error of the ephemeris considered as of the form $x + \tau y + \tau' z$, τ denoting the time from a medial epoch. Four other unknown quantities were introduced,—two of these relating to the apparent semidiameter, one depending on the micrometer employed, and the last being the correction to ENCKE'S determination of the mean solar parallax. The observations at each place have been independently discussed, and the several groups finally combined in series of approximate solutions by least squares.

The sequel indicates that the results afforded by the series of observations of *Mars*, during the opposition of 1849-50, so far surpass any of the others in precision and trustworthiness, that these, taken alone, promise a closer approach to the desired values than when combined with the three other series.

The resultant determinations of the whole discussion are as follows :

Semidiameter of <i>Mars</i>	= 4.6639 + 1.9681 = 6.63
“ “ <i>Venus</i>	= 8.6625 — 0.3118 = 8.35
Mean Solar Parallax	= 8.5712 — 0.0762 = 8.4950

The great increase of the previously assumed semidiameter of *Mars* is very striking. It has proved impracticable in most cases to free the semidiameter from the possible influence of an irradiation dependent on the observer or on the telescope. The adopted value depends on the Washington and Santiago observations only. The necessity of some increase to the previously adopted value is indicated by six series of observations; being all made, during the first opposition, with the exception of the Cape of Good Hope series.

The propriety of a small diminution of the adopted diameter of *Venus* seems also to be distinctly and strongly pointed out.

Upon the resultant value of the parallax I am not inclined to place any great stress, but cannot refrain from expressing the decided conviction that the value obtained by ENCKE from the Transits of *Venus* in 1761 and 1769 may be improved by a slight decrease; and am inclined to regard the value 8.5000 as being in all probability quite near the truth, and that this value may be advantageously adopted.

Albany, 1858 September 8.

G.

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NO. 22.

FROM A LETTER OF DR. BRUHNS TO THE EDITOR.

Berlin, 1858 September 13.

ALLOW me to communicate to you the detection of Faye's comet, and to send an ephemeris for finding it, in case it should not have been already found in your country. It was detected here September 7 with the refractor, as a very faint nebula; but as the sky soon after began to grow cloudy, no regular observation could be made until the 8th. It was observed by Dr. FÖRSTER and myself:—

1858.	Berlin M.T.	$\angle \alpha$	$\angle \delta$
Sept. 8	13 ^h 45 ^m 36 ^s	82° 53' 5.1	+19° 23' 12.5
9	12 56 25	83 29 5.0	+19 16 35.1

Inasmuch as we have no new elements of this comet than those given by LE VERRIER in the *Astr. Nachr.* N° 541, and which hold good for 1851, I have applied to these elements the amount of the precession, and tried how accurately I could represent the observation of Sept. 8 by varying the time of perihelion passage by assuming

$$T = \text{Sept. 12.63485 Berlin M.T.}$$

The right-ascension could be perfectly represented, and the declination within a minute and forty-seven seconds; but I desired to represent the declination also with accuracy, and, for this purpose, could make still one element variable. To

change the mean motion of the eccentricity seemed undesirable, and the changes in them which would be necessary in order to correspond with the observed declination were too considerable to appear in any degree probable.

Since the inclination is not very great, this also is but comparatively little changed by the perturbation; but by so much more is the node, and as the perturbations since 1843 to 1851 indicate that those in the node have the greatest numerical value, it seemed permissible to increase or diminish the longitude of the node provisionally by a sufficient amount to satisfy the observation of Sep. 8 completely. The necessary increase of longitude of the node only amounts to 8' 10".1, and the resulting provisional elements are

$$\begin{aligned} T &= 1858 \text{ Sept. 12.64204 Berlin M.T.} \\ \pi &= 49^\circ 49' 4.6 \\ Q &= 209 45 23.4 \\ i &= 11 21 36.7 \\ q &= 33 42 43.4 \\ \mu &= 475 .1849 \\ \log a &= 0.5820959; \end{aligned} \quad \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} 1858 \text{ September 13.0}$$

upon which the following ephemeris depends, and which will, I hope, agree within a few minutes of are:

FAYE'S COMET.

Berlin Mean Midnight.

1858	$\angle \alpha$	$\angle \delta$	$\log \Delta$	$\log r$	1858	$\angle \alpha$	$\angle \delta$	$\log \Delta$	$\log r$
Oct. 1	95 53.2	+ 16 1.2			Oct. 17	103 2.3	+ 12 51.5		
2	96 23.1	15 50.3			18	103 25.2	12 38.8		
3	96 52.7	15 39.2	0.1228	0.2336	19	103 47.7	12 26.0	0.0889	0.2400
4	97 21.9	15 28.0			20	104 9.7	12 13.2		
5	97 50.6	15 16.7			21	104 31.1	12 0.3		
6	98 19.0	15 5.2			22	104 52.0	11 47.4		
7	98 47.1	14 53.5	0.1142	0.2349	23	105 12.5	11 34.5	0.0807	0.2421
8	99 14.6	14 41.7			24	105 32.5	11 21.5		
9	99 41.6	14 29.9			25	105 51.8	11 8.5		
10	100 8.3	14 18.0			26	106 10.7	10 55.4		
11	100 34.6	14 5.9	0.1057	0.2364	27	106 29.0	10 42.3	0.0726	0.2444
12	101 0.4	13 53.7			28	106 46.8	10 29.2		
13	101 25.7	13 41.5			29	107 4.1	10 16.1		
14	101 50.6	13 29.2			30	107 20.8	10 3.0		
15	102 15.0	13 16.7	0.0972	0.2381	31	107 36.9	+ 9 49.9	0.0647	0.2469
16	102 38.9	+ 13 4.1							

At the same time I inclose you my investigations concerning the Comet 1858 I.

This comet was detected by Mr. TUTTLE and myself, Jan. 4 and 11. The earliest computed elements showed so great similarity with the Comet 1785 I, that I at first believed the two to be identical. It was soon manifest, however, that the inclination was too discordant to retain this hypothesis, and it became evident that it must be identical with the Comet 1790 II.*

Not very long afterwards it became evident that the observations could only be satisfied by assuming a shorter period than the 68 years from 1790 to 1858, and demanded either $\frac{6.8}{4}$ or $\frac{6.8}{5}$ years as the period. The more extended series of observations may only be represented by assuming the latter period of revolution : a result at which American computers have also arrived in your Journal.

From the observations at Cambridge, January 4, 7, 8 ; Berlin, Jan. 11, 16 ; Altona, Jan. 16 ; Bonn, Jan. 16 : from those at Berlin, Jan. 30, Feb. 26 ; Copenhagen, Jan. 31,

Feb. 2 ; Vienna, Feb. 2 : from those at Berlin, March 2, 3, 4, and Bonn, March 5. I have formed the following three normal apparent places (for Berlin mean noon) :

1858.	α	δ
Jan. 11	2° 50' 20.9	+33° 42' 34.6
Feb. 2	25 32 8.2	+10 28 58.9
March 4	49 38 23.8	-15 17 25.8 ;

for which the times are already free from the influence of aberration. Hence I find the elements :

Epoch =	1858 March 0.0 Berlin M.T.
M =	0° 19' 11.20
π =	115 52 39.30
Q =	269 3 42.70
i =	54 23 39.30
q =	55 8 11.70
μ =	259' 8338
$\log a$ =	0.7568740
Period =	13 ^s 239 ^d .55

With these elements, the following ephemeris is computed for the whole series of observations.

EPHEMERIS OF THE FIRST COMET OF 1858.

Berlin Mean Noon.

1858.	α	δ	$\log \Delta$	$\log r$	Aberration-time.
Jan. 4	354 54 36.4	+40 17 40.2	9.905943	0.105694	^m 6 37.2
5	356 3 10.7	39 24 0.4	9.903240		6 34.7
6	357 11 36.0	38 29 22.6	9.900673		6 32.3
7	358 19 50.6	37 33 48.2	9.898244		6 30.1
8	359 27 52.4	36 37 18.3	9.895960	0.094173	6 28.1
9	0 35 38.7	35 39 54.9	9.893824		6 26.2
10	1 43 8.3	34 41 39.7	9.891843		6 24.5
11	2 50 19.9	33 42 35.2	9.890014		6 22.9
12	3 57 11.9	32 42 43.7	9.888347	0.082894	6 21.4
13	5 3 43.3	31 42 9.5	9.886847		6 20.1
14	6 9 51.8	30 40 55.8	9.885515		6 18.9
15	7 15 36.3	29 39 5.3	9.884357		6 17.9
16	8 20 55.4	28 36 40.7	9.883373	0.071959	6 17.0
17	9 25 47.9	27 33 45.7	9.882565		6 16.3
18	10 30 12.8	26 30 24.3	9.881935		6 15.8
19	11 34 8.8	25 26 39.8	9.881484		6 15.4
20	12 37 35.1	24 22 36.0	9.881210	0.061489	6 15.2
21	13 40 30.8	23 18 16.4	9.881116		6 15.1
22	14 42 55.1	22 13 45.4	9.881200		6 15.2
23	15 44 47.0	21 9 6.7	9.881460		6 15.4
24	16 44 6.2	20 4 24.0	9.881894	0.051614	6 15.8
25	17 46 51.6	18 59 41.0	9.882502		6 16.3
26	18 47 3.2	17 55 1.6	9.883281		6 17.0
27	19 46 40.3	16 50 29.4	9.884224		6 17.8
28	20 45 42.9	15 46 7.7	9.885329	0.042477	6 18.7
29	21 44 10.3	14 42 0.5	9.886593		6 19.8
30	22 42 2.5	13 38 11.1	9.888014		6 21.0
31	23 39 19.3	12 34 42.5	9.889583		6 22.4
Feb. 1	24 36 0.8	11 31 37.7	9.891296	0.034227	6 24.0
2	25 32 7.3	10 28 59.9	9.893146		6 25.6
3	26 27 38.4	9 26 51.8	9.895127		6 27.4
4	27 22 34.4	+ 8 25 16.1	9.897236		6 29.3

* See *Astr. Journal* V, pp. 101, 112.

1858.	α			δ			$\log \Delta$	$\log r$	Aberration-time.
	^o	[']	["]	^o	[']	["]			^m ^s
Feb. 5	28	16	55.7	+	7	24 15.2	9.899470	0.027016	6 31.3
6	29	10	42.7		6	23 51.4	9.901818		6 33.4
7	30	3	55.8		5	24 6.5	9.901265		6 35.6
8	30	56	35.2		4	25 2.7	9.906810		6 37.9
9	31	48	41.7		3	26 41.1	9.909450	0.020989	6 40.4
10	32	40	15.4		2	29 3.5	9.912173		6 42.9
11	33	31	16.6		1	32 10.9	9.914975		6 45.5
12	34	21	46.3	+	0	36 4.7	9.917851		6 48.2
13	35	11	44.9	—	0	19 14.6	9.920798	0.016279	6 51.0
14	36	1	12.9		1	13 45.9	9.923801		6 53.9
15	36	50	10.8		2	7 29.2	9.926848		6 56.8
16	37	38	39.4		3	0 23.6	9.929944		6 59.8
17	38	26	39.3		3	52 28.8	9.933082	0.012995	7 2.8
18	39	14	11.4		4	43 44.6	9.936252		7 5.9
19	40	1	16.3		5	34 11.5	9.939450		7 9.0
20	40	47	54.7		6	23 49.2	9.942671		7 12.2
21	41	34	7.4		7	12 38.0	9.945910	0.011220	7 15.4
22	42	19	55.2		8	0 38.0	9.949160		7 18.7
23	43	5	18.8		8	47 49.4	9.952419		7 22.0
24	43	50	19.3		9	34 12.6	9.955683		7 25.3
25	44	34	57.5		10	19 48.4	9.958947	0.010998	7 28.7
26	45	19	14.3		11	4 36.6	9.962204		7 32.1
27	46	3	10.8		11	48 38.2	9.965454		7 35.5
28	46	46	47.7		12	31 53.5	9.968694		7 38.9
Mar. 1	47	30	6.3		13	14 23.1	9.971920	0.012334	7 42.3
2	48	13	7.6		13	56 7.8	9.975426		7 45.7
3	48	55	52.8		14	37 8.4	9.978313		7 49.1
4	49	38	23.2		15	17 25.3	9.981477		7 52.5
5	50	20	39.7		15	56 59.5	9.984615	0.015195	7 56.0
6	51	2	43.5		16	35 51.4	9.987726		7 59.5
7	51	44	35.7		17	14 2.2	9.990806		8 2.9
8	52	26	17.2		17	51 32.2	9.993853		8 6.3
9	53	7	49.5		18	28 22.7	9.996867	0.019509	8 9.7
10	53	49	13.7		19	4 34.2	9.999848		8 13.1
11	54	30	31.1		19	40 7.6	0.002792		8 16.4
12	55	11	43.1		20	15 3.8	0.005696		8 19.8
13	55	52	50.1		20	49 23.8	0.008559	0.025173	8 23.1
14	56	33	53.7		21	23 8.6	0.011382		8 26.4
15	57	14	55.0		21	56 18.9	0.014166		8 29.6
16	57	55	54.8		22	28 55.6	0.016912		8 32.8
17	58	36	51.2		23	0 59.6	0.019617	0.032062	8 36.0
18	59	17	54.3		23	32 31.7	0.022278		8 39.2
19	59	58	57.2		24	3 32.5	0.024895		8 42.3
20	60	40	2.8		24	34 3.0	0.027471		8 45.4
21	61	21	12.3		25	4 3.6	0.030006	0.040031	8 48.5
22	62	2	27.0		25	33 35.4	0.032498		8 51.5
23	62	43	47.8		26	2 39.2	0.034948		8 54.5
24	63	25	15.7		26	31 15.7	0.037358		8 57.5
25	64	6	51.7	—	26	59 25.5	0.039728	0.048930	9 0.4

There are 206 observations known to me, partly from the *Astr. Nachrichten*, partly from your *Journal*, partly from your communication; and I have compared 200 of these with the above ephemeris. They were made in Berlin, Altona, Bonn, Kremsmünster, Vienna, Copenhagen, Florence, Olmütz, Liverpool, Königsberg, Göttingen, Hamburg, Toulouse, Paris, Cambridge, and Ann-Arbor; and consist solely of differential observations made either with the filar-micrometer of refractors, ring-micrometer, light-point micrometer, heliometer, or equatorial instruments.

The comet was always compared with stars in close proximity, and its positions therefore were dependent upon the comparison-stars for a definite determination of the orbit. I consider that beside computing the amount of its perturbations during the time of observation, the determinations of the comparison-stars with a meridian-circle is also necessary; and it is hoped that those observatories which have not yet published their observations, together with the comparison-stars, will soon make them known. As far as the observations are yet made public, they deviate from the ephemeris already given by the following amounts (C.—O.):

1. BERLIN.

The observations will soon appear in the *Astr. Nachrichten*.

1858.	da	dδ	1858.	da	dδ
Jan. 11	+ 0.8	+ 4.7	Feb. 10	- 7.8	+ 5.4
16	- 4.1	+ 0.4	12	- 3.5	+ 0.1
17	+ 8.0	+ 6.0	17	- 0.6	+ 2.8
21	+ 2.7	+ 16.1	18	+ 14.5	+ 3.6
22	+ 4.1	+ 9.2	19	+ 6.8	- 2.7
24	- 7.1	+ 11.5	22	+ 6.2	+ 4.7
26	+ 3.8	+ 8.2	24	+ 1.7	+ 1.3
27	+ 4.6	+ 8.0	25	+ 1.0	+ 2.3
28	+ 1.5	+ 6.9	Mar. 2	- 4.7	+ 1.3
29	+ 1.7	+ 9.5	3	- 1.4	- 2.6
30	- 2.5	+ 6.3	4	+ 0.4	+ 0.3
Feb. 2	+ 7.7	- 2.3	11	+ 16.2	+ 8.6
6	- 3.1	- 3.2	12	+ 0.6	- 4.6
9	- 6.3	- 3.1			

2. ALTONA.

These observations will be found in the *Astr. Nachrichten*, No. 1125.

1858.	da	dδ
Jan. 16	+ 8.1	- 19.1
21	- 9.7	+ 4.7

3. BONN.

A part of the observations are in Nos. 1125, 1130 of the *Astr. Nachrichten*; the remainder have been sent me in MS. by Dr. WINNEKE.

1858.	da	dδ	1858.	da	dδ
Jan. 16	- 4.3	+ 6.8	Feb. 8	+ 2.5	- 8.3
Feb. 6	- 12.7	+ 4.0	9	- 12.3	- 8.9
7	- 13.1	+ 12.2	18	- 10.4	+ 1.8
7	- 8.6	+ 1.8	19	+ 0.1	- 4.5
8	- 30.8	- 17.6	Mar. 5	+ 0.5	+ 1.9

4. KREMSMÜNSTER.

The observations are published in the *Astr. Nachrichten*, No. 1138.

1858.	da	dδ	1858.	da	dδ
Jan. 30	- 27.3	+ 30.9	Feb. 19	+ 0.6	+ 0.8
Feb. 2	- 0.2	+ 7.4	20	+ 13.9	+ 13.0
3	- 16.9	+ 13.2	23	+ 2.9	+ 7.7
4	- 15.7	+ 8.0	24	- 4.4	+ 11.7
7	- 7.5	+ 8.2	25	- 6.8	+ 14.9
10	- 11.9	+ 1.9	26	- 3.4	+ 6.4
11	- 22.5	+ 4.5	27	- 5.2	+ 1.6
12	- 9.1	+ 1.4	28	- 6.1	+ 1.5
13	- 3.0	+ 3.0	Mar. 4	- 3.6	- 0.6
14	- 6.2	+ 8.4	10	+ 4.1	+ 2.4
18	+ 9.7	+ 3.4	13	+ 19.3	- 6.8

5. VIENNA.

The observations are in the *Astr. Nachrichten*, No. 1147.

1858.	da	dδ	1858.	da	dδ
Feb. 2	- 5.0	- 2.7	Feb. 12	- 9.3	- 4.6
4	- 18.6	- 3.3	16	- 5.4	+ 0.6
10	- 11.5	- 4.0			

6. COPENHAGEN.

The observations are in the *Astr. Nachrichten*, Nos. 1130, 1131.

1858.	da	dδ	1858.	da	dδ
Jan. 17	+ 12.5	- 28.9	Feb. 9	- 7.0	- 10.6
23	- 70.0	+ 38.9	10	- 10.8	- 77.3
24	+ 72.9	- 26.0	12	+ 1.2	- 5.4
29	+ 27.6	+ 112.8	16	+ 13.0	- 20.3
31	+ 0.9	- 1.9	17	- 18.6	- 2.9
Feb. 2	- 2.9	- 8.4	21	- 14.3	- 0.2
7	- 1.1	- 6.7	22	- 5.8	+ 14.1

7. FLORENCE.

The observations are in the *Astr. Nachrichten*, No. 1137.

1858.	da	dδ	1858.	da	dδ
Feb. 2	- 4.9	- 9.2	Mar. 3	- 11.8	+ 10.9
3	- 11.9	- 7.1	6	- 2.4	- 13.9
6	- 5.6	- 9.1	10	+ 1.5	- 7.5
8	- 11.3	+ 13.5	12	- 24.8	+ 10.0
12	- 3.1	+ 6.8	13	+ 10.4	- 51.7
13	+ 15.0	- 39.7	15	- 11.9	- 19.9
15	- 1.2	+ 1.2	16	- 16.6	- 1.9
17	- 6.2	- 5.8	17	- 25.8	- 19.8
22	- 13.5	+ 4.3	18	- 22.1	- 18.8

8. OLMÜTZ.

The observations are in No. 1140 of the *Astr. Nachrichten*.

1858.	da	dδ	1858.	da	dδ
Jan. 17	- 18.2	+ 6.5	Feb. 10	- 16.2	+ 14.3
Feb. 2	- 7.7	+ 28.9	11	- 3.7	+ 30.1
4	- 16.6	+ 10.3	Mar. 3	- 14.6	+ 10.1
4	- 14.7	+ 0.8	4	- 11.3	- 4.8
7	- 14.9	+ 5.3	4	- 11.7	+ 7.4
7	- 4.3	+ 3.9			

9. LIVERPOOL.

The observations are in the *Astr. Nachrichten*, No. 1140.

1858.	da	dδ	1858.	da	dδ
Feb. 6	- 0.9	+ 14.6	Feb. 15	+ 6.8	+ 12.8
6	+ 1.6	+ 25.2	15	+ 6.4	+ 1.6
6	+ 3.9	+ 32.3	15	+ 9.3	+ 14.2
8	+ 4.4	+ 11.9	16	- 6.0	+ 7.2
8	+ 3.8	+ 13.6	16	- 1.1	+ 6.6
8	+ 5.9	+ 16.3	16	- 3.8	+ 10.5

10. KÖNIGSBERG.

The observations are in the *Astr. Nachrichten*, No. 1142.

1858.	da	dδ	1858.	da	dδ
Jan. 30	+ 24.1	- 8.6	Feb. 9	- 1.9	- 0.5
Feb. 4	+ 4.3	+ 16.8	10	+ 2.9	+ 12.6
6	+ 7.8	- 28.1	10	- 8.9	+ 9.8
7	+ 1.5	- 11.6	11	- 1.6	+ 7.7
8	+ 6.2	- 6.2	11	- 1.0	+ 10.6
8	+ 3.7	- 10.0	12	+ 8.0	- 3.5
9	- 2.9	+ 2.9			

11. GÖTTINGEN.

The observations are in the *Astr. Nachrichten*, No. 1148.

1858.	da	dδ	1858.	da	dδ
Feb. 7	- 2.1		Feb. 18	- 6.5	- 1.8
10	+ 8.5	- 2.7	19	+ 31.8	- 18.3
12	+ 0.3	- 0.5	20	+ 8.9	
12	+ 4.3		Mar. 3	+ 1.0	- 3.1
17	+ 0.1	+ 5.6	8	+ 3.1	- 21.0

12. HAMBURG.

Mr. RÜMKE has published his observations in No. 1148 of the *Astr. Nachrichten*.

1858.	da	dδ	1858.	da	dδ
Jan. 16	+ 9.4	+ 0.2	Feb. 16	+ 16.0	- 8.4
Feb. 8	+ 4.7	+ 17.0	17	- 3.4	+ 7.0
8	+ 9.4	+ 10.5	17	+ 5.9	- 10.9
9	- 8.3		18	+ 13.9	+ 3.4
9	- 4.1	- 0.6	18	+ 3.8	+ 6.8
9		- 8.6	Mar. 2	+ 5.8	+ 5.0
10		- 0.9	3	- 2.9	- 10.3
10	- 2.0		3	- 6.8	- 17.7
10	- 2.4		5	- 11.3	- 19.8
10		+ 2.3			

13. PARIS.

The observations are contained in the Meteorological Bulletin of July 25.

1858.	da	$d\delta$	1858.	da	$d\delta$
Jan. 19	+16.3	-9.2	Feb. 9	+11.1	-5.6
Feb. 1	+5.8	-7.4	9	+11.7	-15.2
6	-13.9	+1.2	17	+1.8	+16.4
7	-3.7	-6.2	18	+1.8	+9.6
8	+8.7	+8.6	19	-10.9	+2.2

14. CAMBRIDGE.

The observations are published in the *Astr. Journal*, No. 114, and the *Astr. Nachrichten*, Nos. 1125 and 1149.

1858.	da	$d\delta$	1858.	da	$d\delta$
Jan. 4	-6.0	-6.1	Mar. 12	-18.5	+4.1
7	-7.1	-1.2	18	-8.4	-2.6
8	-9.5	-7.2	23	-3.6	+1.7
Feb. 6	-5.8	+27.3			

Comparing these observations with one another which were made on one and the same day, so large differences become manifest that they cannot be attributed alone to errors in the comparison-stars. It seems as if this faint object, resembling a diffused nebula, could not have presented to one observer the same apparent center that it did to another.

Only when all the comparison-stars shall have been determined anew with the meridian-circle, and reduced anew with the same constants, will it be possible to determine the

16. ANN-ARBOR.

The observations are given in the *Astr. Journal*, No. 115.

1858.	da	$d\delta$	1858.	da	$d\delta$
Jan. 19	-7.9	-7.0	Feb. 5	+0.4	+11.5
20	-10.4	-13.1	24	-13.3	+8.4
20	-2.1	-9.9	26	-3.6	-15.4
21	+0.6	+2.6	Mar. 5	-2.7	+7.0
22	-11.2	-1.2	9	+6.3	+8.9
29	-3.5	+6.7	11	+4.2	-11.7
29	-6.0	+3.1	12	-1.6	+9.5
30	-0.5	+8.4	18	+2.4	+14.3
31	-3.5	+1.5	19	+6.8	-2.0
Feb. 3	+3.1	+3.8			

probable error of a single observation at different observatories, and the constant error of the several observers independently of the individuality of the observer, of the instruments used, and of the micrometer : this work I propose to undertake hereafter. Meantime I have computed, with the elements already given, the differential coefficients for the days January 12.0, 28.0, February 13.0, March 1.0 and 17.0, and find the following equations :

$$\begin{aligned}
 \text{Jan. 12.0 } \left\{ \begin{aligned} 0 &= \cos \delta \, d\alpha + 7.9975 \, dM - 5.5593 \, d\varphi - 964.25 \, d\mu + 1.0715 \, d\pi - 0.6402 \, d\Omega - 0.0947 \, di \\ 0 &= d\delta - 6.9066 - 0.0913 + 1.73 - 0.2996 + 1.1888 + 0.5234 \end{aligned} \right. \\
 \text{Jan. 28.0 } \left\{ \begin{aligned} 0 &= \cos \delta \, d\alpha + 8.6020 - 5.0294 - 872.79 + 0.8581 - 0.2622 + 0.0116 \\ 0 &= d\delta - 14.4822 + 0.8083 + 185.02 - 0.8144 + 1.2080 + 0.1042 \end{aligned} \right. \\
 \text{Feb. 13.0 } \left\{ \begin{aligned} 0 &= \cos \delta \, d\alpha + 7.0753 - 3.8743 - 673.59 + 0.5223 + 0.0667 - 0.0834 \\ 0 &= d\delta - 18.1035 + 0.3252 + 127.86 - 1.0171 + 0.9521 - 0.1544 \end{aligned} \right. \\
 \text{Mar. 1.0 } \left\{ \begin{aligned} 0 &= \cos \delta \, d\alpha + 4.9017 - 2.8689 - 499.14 + 0.2260 + 0.2402 - 0.2750 \\ 0 &= d\delta - 17.9892 - 0.7218 - 37.05 + 1.0225 + 0.6959 - 0.2208 \end{aligned} \right. \\
 \text{Mar. 17.0 } \left\{ \begin{aligned} 0 &= \cos \delta \, d\alpha + 3.3109 - 2.2133 - 387.25 + 0.0284 + 0.2775 - 0.4788 \\ 0 &= d\delta + 16.3383 - 1.6783 - 195.51 - 0.9821 + 0.5389 - 0.2128 \end{aligned} \right.
 \end{aligned}$$

These coefficients hold good only for the assumed elements when μ is changed by $+1''$. If the coefficients of $d\mu$ are changed by any considerable amount, I find for

$$\mu = 260''.8338 \text{ instead of } \mu = 259''.8338,$$

the coefficients of $d\mu$ are,

$$\begin{aligned}
 \text{Jan. 12 } \left\{ \begin{aligned} -959.01 \\ +1.94, \end{aligned} \right. & \text{Jan. 28 } \left\{ \begin{aligned} -869.51 \\ +183.98, \end{aligned} \right. & \text{Feb. 13 } \left\{ \begin{aligned} -671.21 \\ +127.14, \end{aligned} \right. \\
 \text{March 1 } \left\{ \begin{aligned} -497.96 \\ -36.95, \end{aligned} \right. & \text{March 17 } \left\{ \begin{aligned} -386.31 \\ -194.87; \end{aligned} \right.
 \end{aligned}$$

and it consequently follows that in a solution by the method of least squares, the residual errors from the above equations of condition will not agree precisely with those obtained by direct computation, especially if the correction of $d\mu$ be considerable ; and that then perhaps a second solution would be requisite.

For a change of μ by $-0''.8762$, substitution and computation will nevertheless agree closely, as indicated by the following example. I have, namely, taken the deviations of the

Berlin observations alone, for the sake of employing them for a provisional improvement of the elements. I find by the observations from Jan. 11 to 21, with the addition of the three Cambridge observations Jan. 4, 7 & 8 ; by the Berlin observations from Jan. 22 to Feb. 2, from Feb. 2 to 22, and from Feb. 25 to March 12,

$$\begin{aligned}
 & \cos \delta \, d\alpha & d\delta \\
 \text{Jan. 12.0} & -2.4 & +1.0 \\
 & 28.0 & +1.7 \\
 \text{Feb. 13.0} & +0.8 & +1.1 \\
 \text{Mar. 1.0} & +2.4 & +0.9;
 \end{aligned}$$

and these $\cos \delta \, d\alpha$ and $d\delta$ being substituted in the first eight equations of condition, give, by the method of least squares,

$$\begin{aligned}
 dM &= -1.70 \\
 d\varphi &= +139.74 \\
 d\mu &= -0.8762 \\
 d\pi &= -64.25 \\
 d\Omega &= -29.66 \\
 di &= -31.17;
 \end{aligned}$$

so that the most probable system of elements corresponding to the Berlin observations is

Epoch 1858 March 0.0 Berlin M.T.
 $M = 0^{\circ} 19' 9.50''$
 $\pi = 115' 51'' 35.05$
 $\Omega = 269' 3'' 13.04$
 $i = 54' 24'' 10.47$
 $q = 55' 10'' 31.44$
 $\mu = 258.9576$
 $\log a = 0.7578519$;
 and the residual errors are,

	Jan. 12.0	Jan. 28.0	Feb. 13.0	Mar. 1.0
by substitution,	$\begin{cases} -0^{\circ}7 \\ -1.2 \end{cases}$	$\begin{cases} +1^{\circ}8 \\ +2.6 \end{cases}$	$\begin{cases} -0^{\circ}9 \\ -2.4 \end{cases}$	$\begin{cases} +0^{\circ}1 \\ +1.3 \end{cases}$
by direct computation,	$\begin{cases} +0.6 \\ -1.4 \end{cases}$	$\begin{cases} +2.8 \\ +2.0 \end{cases}$	$\begin{cases} 0.0 \\ -2.6 \end{cases}$	$\begin{cases} +1.1 \\ +1.2 \end{cases}$

Only after all observations shall have been published, and the comparison-stars determined anew, can the investigation be continued.
 C. BRUHNS.

ON THE NEW ASTEROID TAKEN AND OBSERVED IN 1857 FOR DAPHNE.

BY E. SCHUBERT.

TO PROFESSOR JOSEPH WINLOCK.

CHARGED by you also with the farther computations on *Daphne*, I computed in the first place a new orbit from the observations in 1857; since the elements from those in 1856 cannot be relied on, the observed arc in that year having been very small. From the following three observations made by Dr. FÖRSTER at Berlin,

	Berlin M.T.	a	δ
1857 Sept. 16	13 ^h 0 ^m 44 ^s	348° 5' 45.3	+1° 13' 14.0
23	10 9 4	346 56 58.2	+0 3 56.7
30	11 56 27	345 58 52.5	-1 3 22.2

were obtained the following elements, which are corrected for aberration and parallax : Mr. PAPE found for *Daphne* :

1857 Sept. 16.5356 Berlin M.T.	1856 June 0.5 Berlin M.T.
Mean Equinox 1858.0	Mean Equinox 1858.0
$M = 32^{\circ} 31' 24.4''$	$M = 332^{\circ} 7' 18.7''$
$\pi = 303' 17'' 41.6$	$\pi = 230' 21'' 29.8$
$\Omega = 195' 29'' 52.9$	$\Omega = 180' 5' 50.8$
$i = 7' 38'' 19.1$	$i = 15' 48'' 23.0$
$q = 11' 42'' 3.8$	$q = 11' 40'' 57.0$
$\mu = 880.010$	$\mu = 954.110$
$\log a = 0.403679$	$\log a = 0.38027$

The middle place is represented thus :

$d\lambda$	$d\beta$
+0.6	±0.0

From these elements, I computed for 1856 June 2.83964 Berlin M.T.,

a	δ
175° 22' 37.8	+2° 21' 41.2

but the mean from five observations (Berlin and Vienna) for that time is

159° 28' 33.2	+10° 52' 42.0
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Having made sure that no mistake had occurred in the reduction or the copying of the observations for the computation of the orbit, or in my calculation, I did not hesitate to say that two different planets had been observed in 1856 and 1857. To show the incompatibility in another way, I undertook the rather troublesome task of computing an orbit from

1856 June 2, 10^h 47^m 8^s.5 Berlin M.T.

$a = 159^{\circ} 19' 33.5$ $\delta = +10^{\circ} 53' 43.1$

(mean from Berlin and Vienna on that day); and from the above observations of Sept. 16 and Sept. 30 in 1857, the resultant elements are :

1856 June 2.43993 Berlin M.T.

$M = 343^{\circ} 39' 35.0$	} M. Eq. 1858.0
$\pi = 242' 30'' 34.3$	
$\Omega = 180' 33'' 2.5$	
$i = 22' 59'' 41.0$	
$q = 32' 32'' 44.9$	
$\mu = 461.592$	
$\log a = 0.590499$	

The elements represent the fundamental places thus :

C.—0.	
$d\lambda$	$d\beta$
+1.7	+1.0
-3.1	-0.2
+1.0	-0.3

but for the independent observation of Sept. 23 (in the middle between Sept. 16 and Sept. 30), they leave

+126.7	-46.3
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which shows beyond all doubt that not *Daphne* has been found and observed in 1857, but a new planet unknown till now.

For this new asteroid, I have computed from the above elements the following ephemeris :

Berlin Mean Midnight.

1858	α	δ	$\log r$	$\log \Delta$	1859	α	δ	$\log r$	$\log \Delta$
	^h ^m ^s	[°] ['] ["]				^h ^m ^s	[°] ['] ["]		
Oct. 1	7 1.8	+15 22	0.4606	0.4524	Jan. 1	6 46 1.5	+11 41 14		
5	5.0	15 6			8 3	44 3.3	43 28		
9	7.8	14 50	4623	4367	5	42 5.7	46 3	0.4763	0.3066
13	10.4	14 34			7	40 9.2	48 57		
17	12.6	14 18	4638	4203	9	38 14.3	52 10		
21	14.5	14 2			11	36 21.4	55 41		
25	16.1	13 46	4654	4034	13	34 31.0	11 59 28	4772	3118
29	17.3	13 31			15	32 43.6	12 3 31		
Nov. 2	18.1	13 16	4668	3864	17	30 59.6	7 49		
6	18.6	13 2			19	29 19.3	12 21		
10	18.6	12 48	4682	3696	21	27 43.0	17 7	4781	3207
14	18.3	12 36			23	26 11.1	22 5		
18	17.5	12 24	4696	3534	25	24 43.9	27 14		
22	16.3	12 13			27	23 21.6	32 33		
26	14.7	12 4	4708	3385	29	22 4.4	38 2	4789	3329
30	12.7	11 55			31	20 52.6	43 40		
Dec. 4	10 18.3	11 48 15	4720	3257	Feb. 2	19 46.5	49 25		
6	8 58.7	45 19			4	18 46.1	12 55 17		
8	7 34.1	42 46			6	17 51.7	13 1 15	4796	3477
10	6 4.6	40 34			8	17 3.3	7 18		
12	4 30.5	38 45	4732	3155	10	16 20.9	13 24		
14	2 52.3	37 19			12	15 44.6	19 33		
16	7 1 10.1	36 15			14	15 14.5	25 45	4803	3644
18	6 59 24.4	35 34			16	14 50.5	31 58		
20	57 35.6	35 16	4743	3086	18	14 32.6	38 11		
22	55 44.2	35 20			20	14 20.8	44 24		
24	53 50.5	35 47			22	14 15.0	50 37	4809	3823
26	51 54.8	36 36			24	14 15.3	13 56 48		
28	49 57.8	37 47	0.4753	0.3056	26	14 21.5	14 2 56		
30	6 47 59.8	+11 39 20			28	14 33.2	9 1		
					Mar. 2	6 14 50.7	+14 15 3	0.4815	0.4008

8 1859 January 1^d 17^h 18^m.7 Berlin M.T. Intensity of light = 0.41.

OBSERVATION OF THE ALGOL-MINIMUM OF 1858 OCT. 9, AT WASHINGTON (D.C.).

BY CHARLES A. SCHIOTT,

ASSISTANT U. S. COAST SURVEY.

SKY generally clear, with a few clouds passing over *Perseus*.

Time by Watch.

Comparison of Brightness.

6 ^h 48 ^m	$\beta \frac{1}{2} \varrho$	$\beta = \delta$
54	$\frac{1}{2}$	=
7 0	-----	= a cloud passing over ϱ
6	$\frac{1}{4}$	$\delta \frac{1}{4} \beta$
12	$\frac{1}{4}$	$\frac{1}{4}$
18	=	$\frac{1}{4}$
24	=	$\frac{1}{2}$
30	$\beta = \varrho$	$\frac{1}{4}$
36	$\varrho = \beta$	$\frac{1}{2}$
42	$\varrho \frac{1}{4} \beta$	$\frac{1}{4}$
48	$\varrho = \beta$	$\frac{1}{4}$
54	$\beta = \varrho$	$\frac{1}{4}$
8 0	=	$\frac{1}{4}$
6	=	=
12	$\frac{1}{4}$	=
18	$\frac{1}{4}$	$\delta = \beta$
24	$\frac{1}{4}$	$\beta = \delta$
30	$\beta \frac{1}{4} \varrho$	=

ϱ appeared brighter than usual, and of a reddish color.

TIME OF MINIMUM BY COMPARISON WITH

	δ	ϱ	
at $\frac{1}{2}$	7 ^h 30 ^m 0	7 ^h 42 ^m 0	at $\frac{1}{4}$
$\frac{1}{4}$	31.5	42.0	=
=	37.5	42.0	=
=	42.0	42.0	$\frac{1}{4}$
Mean	7 ^h 35 ^m 3	7 ^h 42 ^m 0	

Watch fast 7^h 38^m 6
6 .8

Observed minimum 7^h 31^m 8 Washington mean time.

For convenience of reference, I add a recapitulation of my observations of *Algol*, together with the resulting period.

OBSERVED MINIMUM. Washington Mean Time.			Equation of light.	Number of periods.	Resulting period of variability.
1855 February 28	h	m	— 2.1	+ 7026	$\frac{1318^d.945}{460}$ $= 2^d 20^h 48^m 52^s.3 \pm 0^s.24$
1856 November 11	13	31.5	+ 7.6	+ 7243	
1856 December 4	12	5.0	+ 7.1	+ 7251	
1858 January 21	9	19.4	+ 2.9	+ 7395	
1858 March 5	9	40.2	— 2.7	+ 7410	
1858 October 9	7	31.8	+ 6.0	+ 7486	

which result refers to the year 1857 and to Argelander's period +7302.

APPEARANCE OF THE GREAT COMET OF 1858.

NUMEROUS observers mention the divided appearance of the tail of this comet.

Mr. DAVID TROWBRIDGE, of Perry city, N.Y., writes :

"I noticed on the evening of the 9th inst. that the tail of the comet appeared to the naked eye divided into four branches, throughout the last 10° of its extremity. I tried many means to see if it were not an optical illusion, but found it divided every time. I saw it so again on the 10th, but not so plain."

Mr. LEWIS SWIFT, Postmaster at Hunt's corners, N.Y., writes :

"On the evening of the 9th inst. I noticed what seemed to be a multiple appearance of its tail. The tail was distinctly

though faintly visible to ϵ *Herculis*, and considerably curved, the curve of the concavity differing from that of the convexity. The tail, for about 5° from ϵ *Herculis*, seemed divided into several parts; or, rather, there were visible three dark stripes, some 5° in length, and near the center, the middle one being most conspicuous. By looking a little to one side, I fancied that I could see *five*. I am describing the appearance to the naked eye. I observed the same appearances the following evening, but they were not so striking."

The same phenomenon was noticed by the observers at the Dudley Observatory.

G.

NEW WORKS.

1. *Memoirs of the Royal Astronomical Society of London.* Vol. XXVI. 1858.

THIS volume contains the following memoirs, presented during the session of 1856-7 :

- I. Formula for deducing the latitude of an observatory, from observations of stars with a transit-instrument placed in the prime vertical. The latitude of Liverpool Observatory so obtained. By W. H. SIMMS, Esq.
- II. Telescopic appearances of the Planet *Saturn* during the apparition of 1855-6, as observed with an 8-inch object-glass. By the Rev. W. R. DAWES.
- III. On the corrections to be applied to observations made with the sextant. By W. H. SIMMS, Esq.
- IV. On the value of the constant of refraction, as determined from zenith distance observations of stars near the north and the south horizon, at the Royal Observatory, Greenwich, in the years from 1836 to 1854. By the Rev. ROBERT MAIN.
- V. On the eclipse of AGATHOCLES, the eclipse at Larissa, and the eclipse of THALES; with an appendix on the eclipse at Sticklastad. By G. B. AIRY, Esq., Astronomer Royal.

Report of the Council to the Society at the Thirty-seventh Annual General Meeting, February 13, 1857.

An Address delivered at the Annual General Meeting of the

Society, February 13, 1857, on presenting the gold medal to M. SCHWABE. By MANUEL J. JOHNSON, Esq.

2. *Giornale Astronomico e Meteorologico del Real Osservatorio di Palermo, pubblicato dal Prof. DOMENICO RAGONA.* Vol. i. Palermo, 1855.

THE series of published Palermo observations has consisted of the volumes of PIAZZI and CACCIATORE; and the present work by Professor RAGONA is intended in part as the commencement of a second series, which shall form a sequel to the former, and in part as a journal for the diffusion of astronomical knowledge.

It appeared in the form of numbers, published at short intervals, and contains Zone-observations made with the Ramsden Circle and the Troughton Equatorial of the Palermo Observatory, extended meteorological records and many isolated astronomical observations, in addition to articles of popular interest.

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NEW WORKS.

ALBANY: C. VAN BENTHUYSEN, PRINTER.

THE ASTRONOMICAL JOURNAL. No. 119.

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ALBANY, 1858, DECEMBER 20.

NO. 23.

ELEMENTS OF PSYCHE AND LEUCOTHEA.

BY E. SCHUBERT.

[Communicated by Prof. WINLOCK, Superintendent American Ephemeris.]

THE work on *Psyche* has been started from the elements published by Dr. KLINKERFUES in No. 1069 of the *Astr. Nachrichten*; they are:

$$\begin{array}{l} 1854 \text{ June } 29.0 \text{ Berlin M.T.} \\ M = 297^\circ 38' 29.4 \\ \pi = 12 \ 30 \ 41.6 \\ \Omega = 150 \ 32 \ 6.1 \\ i = 3 \ 3 \ 57.6 \\ q = 7 \ 50 \ 30.6 \\ \mu = 709''.2317 \\ \log a = 0.466146 \end{array} \left. \vphantom{\begin{array}{l} M \\ \pi \\ \Omega \\ i \\ q \\ \mu \\ \log a \end{array}} \right\} \text{Mean Equation of Epoch}$$

Dr. KLINKERFUES has had the kindness to send me the perturbations of the coördinates by *Jupiter* up to 1857. His data for 1857 Jan. 0 are:

$$\begin{array}{ll} x - x^0 = -0.000322, & \frac{dx}{dt} - \frac{dx^0}{dt} = +0.0000126; \\ y - y^0 = -0.009709, & \frac{dy}{dt} - \frac{dy^0}{dt} = -0.0000307; \\ z - z^0 = +0.000474, & \frac{dz}{dt} - \frac{dz^0}{dt} = +0.0000015. \end{array}$$

From these data I have derived, as the basis of my work,

$$\begin{array}{l} 1857 \text{ January } 0 \text{ Berlin M.T.} \\ M = 117^\circ 54' 47.6 \\ \pi = 12 \ 57 \ 15.6 \\ \Omega = 150 \ 33 \ 36.8 \\ i = 3 \ 4 \ 6.2 \\ q = 7 \ 46 \ 21.6 \\ \mu = 709''.9983 \\ \log a = 0.465833 \end{array} \left. \vphantom{\begin{array}{l} M \\ \pi \\ \Omega \\ i \\ q \\ \mu \\ \log a \end{array}} \right\} \text{Mean Eq. Ep.}$$

With these elements I have computed the variations of the constants by *Jupiter* up to the end of 1860. The osculating elements from which the approximate ephemeris for 1860 is computed, you will find on the same page with the ephemeris.

In the case of *Leucothea*, I proceeded from Mr. RUMKER's elements published in No. 1011 of the *Astr. Nachrichten*:

$$\begin{array}{l} 1855 \text{ May } 0.0 \text{ Greenwich M.T.} \\ M = 359^\circ 32' 30.3 \\ \pi = 198 \ 17 \ 33.9 \\ \Omega = 356 \ 25 \ 11.6 \\ i = 8 \ 15 \ 17.7 \\ q = 12 \ 30 \ 13.5 \\ \mu = 691''.932 \\ \log a = 0.473296 \end{array} \left. \vphantom{\begin{array}{l} M \\ \pi \\ \Omega \\ i \\ q \\ \mu \\ \log a \end{array}} \right\} \text{January } 0 \text{ } 1856$$

To get a little nearer the truth, I compared with these elements an observation made in 1857 on October 19 at Liverpool, and obtained $\Delta \alpha \cos \delta = -1040''.6$ and $\Delta \delta = -557''.5$.

From the equations

$$\begin{array}{l} 0 = -1040.6 + 0.18378 \, d\varphi + 672.289 \, d\mu \text{ and} \\ 0 = -557.5 + 0.07802 \, d\varphi + 419.712 \, d\mu, \\ \text{result} \quad d\varphi = +41' \ 50''.7 \text{ and} \\ \quad \quad \quad d\mu = +0''.86152. \end{array}$$

With these two corrections, therefore, the following elements were adopted for the computation of the perturbations, and for the final corrections to be determined at a later period.

$$\begin{array}{l} 1855 \text{ May } 11.0 \text{ Berlin M.T.} \\ M = 1^\circ 38' 35.9 \\ \pi = 198 \ 17 \ 1.7 \\ \Omega = 356 \ 24 \ 39.6 \\ i = 8 \ 15 \ 17.7 \\ q = 13 \ 12 \ 4.2 \\ \mu = 692''.7935 \\ \log a = 0.472936 \end{array} \left. \vphantom{\begin{array}{l} M \\ \pi \\ \Omega \\ i \\ q \\ \mu \\ \log a \end{array}} \right\} \text{Mean Eq. Ep.}$$

The osculating elements for the approximate ephemeris for 1860 are with the perturbations and the ephemeris.

FROM A LETTER OF DR. SCHÖNFELD TO THE EDITOR.

Bonn, 1858 November 1.

I TAKE the liberty of begging you to insert the two inclosed computations in your Journal; the one from Professor ARGELANDER, the other from myself.

The first is an ephemeris of those minima of *S Cancri* which will occur previous to the next conjunction of the star with the Sun, and at times favorable for American observers.

They are deduced from the elements given in N° 1156 of the *Astronomische Nachrichten*.

The second is an ephemeris of *Thetis* for the coming opposition, now near at hand. I have interpolated it for the meridian of Washington from my computations intended for the Berlin *Jahrbuch*, inasmuch as this volume of the *Jahrbuch* will scarcely be received in America before the time of opposition.

The elements from which it is computed were in error at last year's opposition by about $40''$; and since the planet will remain at a considerable distance from the Earth this time, the error of the ephemeris will probably not have increased so much as essentially to embarrass the search for this certainly faint planet. At the time of opposition, December 29, it will scarcely exceed the 11th magnitude.

Professor ARGELANDER has observed the planet detected by Mr. SEARLE as often as the observations for revision of the charts have allowed; but the observations are not yet reduced.

The complete edition of the third part of the "*Durchmusterung*" charts (containing Nos. 1, 4, 9 and 10) was received here the day before yesterday. E. SCHÖNFELD.

MINIMA OF *S CANCRI*, 1858 - 59.

Nov.	20	13 ^h 6 ^s	Washington M.T.
Dec.	9	12 18	
	28	11 31	
Jan.	16	10 44	
Feb.	4	9 59	
	23	9 14	
March	14	8 30	
April	2	7 47	

EPHEMERIS OF *THETIS* FOR THE OPPOSITION, 1858 - 59.

Washington Mean Midnight.

	App. α	App. δ	log Δ	log r
Dec. 11	6 ^h 50 ^m 21 ^s .95	+18° 40' 28".0	0.26205	0.41338
15	49 26.79	42 30.4		
16	48 30.67	41 36.2	0.25987	0.41327
17	47 33.63	46 44.6		
18	46 35.73	48 55.6	0.25796	0.41315
19	45 37.00	51 9.0		
20	44 37.55	53 24.7	0.25632	0.41303
21	43 37.38	55 42.5		
22	42 36.60	58 2.3	0.25494	0.41290
23	41 35.26	+19 0 23.9		
24	40 33.41	2 47.2	0.25385	0.41278
25	39 31.14	5 12.2		
26	38 28.51	7 38.8	0.25304	0.41265
27	37 25.58	10 6.9		
28	36 22.43	12 36.3	0.25252	0.41252
29	35 19.14	15 7.0		
30	34 15.79	17 38.6	0.25230	0.41239
31	33 12.44	20 11.1		
Jan. 1	32 9.19	22 44.4	0.25237	0.41225
2	31 6.10	25 18.5		
3	30 3.24	27 53.2	0.25274	0.41211
4	29 0.68	30 28.4		
5	27 58.51	33 4.2	0.25339	0.41196
6	26 56.79	35 40.1		
7	25 55.60	38 16.2	0.25133	0.41182
8	24 55.03	40 52.4		
9	23 55.13	43 28.8	0.25555	0.41167
10	22 55.96	46 5.2		
11	21 57.60	48 41.5	0.25705	0.41152
12	21 0.10	51 17.8		
13	20 3.54	53 53.7	0.25882	0.41136
14	6 19 7.96	+19 56 29.4		

ELLIPTIC ELEMENTS OF COMET 1858 V.

BY SIMON NEWCOMB.

I HAVE computed elliptic elements of Comet 1858 V from the following normal places, which are corrected for aberration:

Washington M.T.	ℓ α	ℓ δ
1858 June 13.0	9 ^h 25 ^m 29 ^s .41	+24° 58' 46".7
Aug. 22.0	10 20 29.69	+32 33 49.2
Oct. 19.73316	16 47 42.82	-25 19 3.7

The first of these places was determined from observations at Florence, Padua, Berlin and Vienna; the second, from observations at Cambridge and Washington; and the third, from Cambridge observations obtained through the courtesy of Mr. BOND.

ELEMENTS.

T	= 1858 Sep. 29.75120 Washington M.T.
Ω	= 165° 19' 47".1
ω	= 129 6 56.0
$\pi = \Omega - \omega$	= 36 12 51.1
i	= 116 58 36.3
q	= 84 58 55.4
log q	= 9.762308
log a	= 2.1788
Period	= 1854 years.

All the normals are satisfied by these elements within $2''$ or $3''$.

Cambridge, 1858 November 26.

APPARENT RIGHT-ASCENSIONS OF THE MOON'S LIMB AND OF MOON-CULMINATING STARS,

OBSERVED WITH THE TRANSIT-INSTRUMENT OF THE WASHINGTON OBSERVATORY,
BY PROFESSOR JAMES MAJOR.

[Communicated by Commander M. F. MAURY, Superintendent of the Observatory.]

Day of Observation.	Name of Object.	Number of wires observed.	Apparent Right-Ascension.		Day of Observation.	Name of Object.	Number of wires observed.	Apparent Right-Ascension.					
			Observed.	Computed				Observed.	Computed				
			h	m	s			h	m	s			
1858 Jan. 19	Moon I	3	23	36	7.34	7.39	1858 Apr. 24	τ Leonis	5	11	20	40.13	
20	Moon I	5	0	24	37.99	37.68	89 Leonis	5	11	27	8.05		
	ϵ Piscium	5	0	55	34.57		Moon I	5	11	57	28.47	28.71	
	r Piscium	3	1	34	2.97		η Virginis	5	12	12	40.62		
21	Moon I	5	1	14	58.66	58.17	25	Moon I	5	12	43	36.80	36.62
	ϖ Ceti	5	2	20	37.24		ψ Virginis	5	12	47	0.72		
22	β Arctis	5	1	46	48.20		g Virginis	4	13	0	29.94		
	Moon I	5	2	8	37.47	36.84	27	83 Virginis	5	13	36	52.81	
25	τ Tauri	5	4	33	44.91		89 Virginis	5	13	42	12.20		
	i Aurigæ	5	4	47	46.56		Moon I	5	14	18	20.25	20.52	
	Moon I	5	5	17	60.09	59.92	Moon II	5	14	20	30.45	30.80	
Feb. 23	α Aurigæ	5	6	6	21.45		5 Libræ	5	14	38	10.75		
	48 Aurigæ	5	6	19	28.24		α^2 Libræ	5	14	43	4.07		
	Moon I	5	7	8	38.61	38.61	May 20	l Leonis	10	10	41	49.12	
	i Geminorum	5	7	16	56.36		Moon I	15	10	55	56.97	56.47	
	v Geminorum	5	7	27	12.25		σ Leonis	15	11	13	50.55		
24	Moon I	5	8	12	32.18	32.28	v Leonis	14	11	29	42.60		
	γ Cancræ	5	8	24	31.62		Moon I	15	12	13	55.92	55.93	
	γ Cancræ	5	8	35	5.96		τ Virginis	15	13	51	27.65		
25	η Cancræ	5	8	24	31.78		Moon I	15	13	0	15.12	15.21	
	γ Cancræ	5	8	35	5.99		a Virginis	15	13	17	45.24		
	Moon I	5	9	11	58.00	57.92	h Virginis	15	13	25	31.81		
26	π^2 Cancræ	5	9	7	25.46		Moon I	15	14	35	32.65	32.85	
	83 Cancræ	5	9	11	5.24		α^2 Libræ	15	14	43	4.41		
	Moon I	5	10	6	50.54	50.36	12 Libræ	15	14	46	8.46		
	45 Leonis	5	10	20	11.03		20 Libræ	15	14	55	48.76		
	ρ Leonis	5	10	25	21.96		22	Moon I	15	15	26	7.89	8.08
27	45 Leonis	5	10	20	11.07		δ Scorpii	10	15	51	59.70		
	ρ Leonis	5	10	25	21.99		β^1 Scorpii	15	15	57	14.21		
	Moon II	5	10	0	8.75	8.24	BAC 5467	15	16	15	51.05		
	σ Leonis	2	11	13	50.88		a Scorpii	15	16	20	45.67		
	τ Leonis	5	11	20	40.02		ρ Scorpii	15	15	48	10.62		
Mar. 18	Moon I	15	2	29	18.17	18.05	δ Scorpii	15	15	51	59.68		
20	Moon I	15	4	33	33.07	32.93	Moon I	15	16	19	2.30	2.63	
24	Moon I	15	8	51	43.45	43.89	a Scorpii	15	16	20	45.69		
25	ϵ Leonis	15	9	37	49.30		τ Scorpii	15	16	27	6.24		
	Moon I	15	9	46	48.27	48.42	θ Ophiuchi	15	17	13	20.94		
	a Leonis	15	10	0	50.49		24	a Scorpii	15	16	20	45.69	
29	q Virginis	5	12	26	29.36		τ Scorpii	14	16	27	6.31		
	χ Virginis	5	12	31	57.46		θ Ophiuchi	14	17	13	20.98		
	Moon II	5	13	2	38.16	37.97	Moon I	10	17	13	48.90	48.90	
	a Virginis	5	13	17	45.02		25	θ Ophiuchi	10	17	13	20.99	
	h Virginis	5	13	13	31.57		d Ophiuchi	15	17	18	21.04		
Apr. 21	79 Cancræ	2	9	2	12.75		μ^1 Sagittarii	10	18	5	19.83		
	83 Cancræ	5	9	11	4.69		Moon I	5	18	9	25.18	25.94	
	Moon I	5	9	30	24.62	24.69	δ Sagittarii	10	18	11	57.95		
	r Leonis	5	9	50	36.74		λ Sagittarii	10	18	19	16.03		
	a Leonis	5	10	0	50.19								

NOTE. The transits over more than five wires were observed by the electro-magnetic method. The observation of the Moon on June 25 is not considered very good; it was also recorded by this method, and a correction -0.02 applied for defective illumination. The computed right-ascensions are taken from the *American Ephemeris*.

OBSERVATIONS OF COMETS 1858 V AND 1858 VI, AND OF EGERIA AND THE
55th ASTEROID,

MADE WITH THE FILAR MICROMETER OF THE WASHINGTON EQUATORIAL,

By JAMES FERGUSON.

[Communicated by Commander MAURY.—Corrected for refraction.]

COMET 1858 V.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	— *		s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 Oct. 9*	^h 6 ^m 36 ^s 35.1	4	S. Cat. Gen. 1683	^m + 3 ^s 36.97	['] + 17 ["] 34.17	^h 15 ^m 0 ^s 42.49	[°] + 6 ['] 20 ["] 40.14
13	6 26 21.1	6	Weisse XV, 848	+ 2 58.50	+ 0 5.33	15 47 12.03	— 7 36 52.83
15	6 41 10.0	5	" XVI, 113	+ 1 5.91	+ 16 39.52	16 8 7.15	14 0 3.02
16	6 45 1.2	5	A. Z. 297, 84	+ 3 3.49	— 12 57.35	16 17 50.34	16 53 57.76
19	6 35 6.0	6	A. Z. 210, 78	+ 2 53.31	+ 3 26.10	16 44 1.57	24 19 55.06

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
Σ 1683 Bor. pree.	7	^h 14 ^m 57 ^s 9.49	[°] + 6 ['] 2 ["] 46.74	STRUVE, Catalogus Generalist.
Weisse XV, 848	8	15 44 18.40	— 7 37 9.90	} WEISSE, Catalogue.
" XVI, 113	8	16 7 6.05	— 14 16 49.72	
A. Z. 297, 84	6	16 14 51.71	— 16 41 6.02	} ARGELANDER'S Zones.
A. Z. 210, 78	7	16 41 13.34	— 24 23 23.36	

COMET 1858 VI.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	— *		s apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1858 Oct. 9	^h 8 ^m 54 ^s 20.6	4	* 4	^m + 0 ^s 38.27	['] + 4 ["] 18.99	^h 23 ^m 8.6	[°] + 17 ['] 7.3
13	8 4 53.8	3	Weisse XXI, 692	+ 4 16.81	— 2 48.29	21 33 44.86	+ 7 12 33.27
14	9 18 13.8	7	* 5	— 1 0.99	+ 2 30.43	21 27	+ 4 48
16	7 30 15.4	4	S. Cat. Gen 2585	— 0 2.12	— 8 13.72	21 14 36.19	+ 1 17 35.39
18	7 59 54.7	8	La Mont, 2477	— 0 4.06	— 9 14.02	21 4 11.68	— 2 1 41.31
19	8 14 4.5	2	* 6	+ 3 34.02	— 18 26.92	20 59.1	— 3 20
20	8 6 10.0	4	Weisse XX, 1475	— 2 37.90	+ 4 16.06	20 55 30.42	— 4 59 34.67
23	7 42 35.3	3	" 1082	+ 2 27.71	— 18 45.24	20 44 59.54	— 8 19 21.07

Adopted Mean Places for 1860.0 of Comparison-Stars.

*	Mag.	α	δ	Authority.
* 4	8.5	^h 22 ^m 8.0	[°] + 17 ['] 3	WEISSE, Catalogue.
Weisse XXI, 692	9	21 29 30.73	+ 7 15 34.79	
* 5	9	21 28	+ 4 46	STRUVE, Catalogus Generalis.
Struve C. G. 2585	7.7	21 14 41.15	+ 1 26 2.45	
Lamont, 2477	8	21 4 18.70	— 1 52 10.72	} WEISSE'S Catalogue.
Weisse XX, 1475	8	20 58 11.37	— 4 55 2.82	
" 1082	9	20 42 35.07	— 8 0 19.48	}
* 6	9	20 56.2	— 3 1	

* The minute of the time of observation doubtful.

† Reduced from STRUVE's observation of the following star; assuming $\Delta = 8''.38$, $P = 234^\circ$.

EGERLI.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	13 — *		13's apparent	
				<i>1a</i>	<i>1δ</i>	<i>α</i>	<i>δ</i>
1858 Sep. 23	^h 9 ^m 35 ^s 20.6	12	B. A. C. 230	+ 1 ^m 6.62	+ 6 58.03	^h 0 ^m 43 ^s 28.60	— 14 [°] 12 ['] 31.11
27	9 37 57.2	2	"	— 3 0.32	— 0 34.39	0 39 21.70	14 20 3.76
28	9 23 42.4	7	Weisse, 0, 642	+ 0 56.57	— 10 26.66	0 38 19.33	14 21 32.47
Oct. 1	9 49 8.8	8	"	— 2 13.14	— 13 44.95	0 35 9.76	— 14 24 50.93

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	<i>α</i>	<i>δ</i>	Authority.
B. A. C. 230	6	^h 0 ^m 42 ^s 24.00	— 14 19 16.92	B. A. Catalogue.
Weisse, 0, 642	8	0 37 24.82	— 14 10 52.93	WEISSE, Catalogue.

FIFTY-FIFTH ASTEROID.

Date.	Washington M.T.	No. Comp.	Comparison-Star.	Planet — Star		Apparent	
				<i>1a</i>	<i>1δ</i>	<i>α</i>	<i>δ</i>
1858 Sep. 13	^h 8 ^m 45 ^s 39.0	6	B. A. C. 243	+ 1 ^m 8.29	— 1 12.02	^h 0 ^m 47 ^s 12.90	+ 3 [°] 18 ['] 8.86
16	9 56 25.4	14	"	— 1 12.05	— 4 46.57	44 52.59	3 14 34.45
17	9 5 57.1	10	"	— 1 58.29	— 6 1.38	44 6.56	3 13 19.72
18	8 44 53.4	10	Weisse, 0, 775	— 1 22.41	— 5 41.05	43 19.18	3 11 59.13
20	9 10 48.4	5	" 711	+ 0 30.44	— 13 28.67	41 36.68	3 9 3.32
22	8 45 54.6	7	" 711	— 1 12.02	— 16 34.68	39 54.24	3 5 57.44
26	9 8 42.1	12	" 608	+ 0 49.36	— 2 10.50	36 18.61	2 58 59.06
27	9 0 15.2	14	" 608	— 0 4.96	— 3 55.57	35 24.31	2 57 14.05
28	8 40 44.0	9	" 595	— 0 17.20	— 5 10.77	34 30.12	2 55 26.42
Oct. 4	9 14 8.1	6	" 443	+ 2 16.45	+ 11 54.99	28 57.05	2 44 33.81
7	8 30 37.2	10	" 443	— 0 25.70	+ 6 45.60	26 14.91	2 39 22.49
9	9 26 53.9	5	" 376	+ 1 8.43	+ 6 40.07	24 25.92	2 36 1.26
14	9 3 45.6	4	" 376	— 3 5.71	— 0 38.87	20 11.79	2 28 42.39
16	8 51 25.7	14	" 287	+ 1 6.03	— 9 23.55	18 26.18	2 26 19.18
18	9 18 15.1	16	" 287	— 0 16.39	— 11 27.71	17 3.76	2 24 15.02
19	7 22 43.1	14	" 287	— 0 56.75	— 12 19.06	16 23.42	2 23 23.67
27	9 14 48.3	12	" 196	— 0 50.47	+ 2 25.28	11 15.83	2 20 0.68
27	9 14 48.3	12	" 212	— 1 40.81	+ 4 50.34	11 15.70	2 19 58.73
Nov. 13	8 28 19.3	3	" 90	+ 0 13.87	+ 3 6.65	0 6 6.53	+ 2 39 46.72

Adopted Mean Places 1860.0 of Comparison-Stars.

*	Mag.	<i>α</i>	Authority.	<i>δ</i>	Authority.
B. A. C. 243	8	[°] 0 46 7.07	W. Transit, Y 1*	+ 3 [°] 19 34.29	W. Mural, Y 3
Weisse, 0, 775	9	44 43.00	" Y 2	3 17 53.38	" Y 2
711	9	41 8.61	" Y 1	3 22 43.94	" Y 1
608	8.5	35 31.56	" Y 3	3 1 24.71	" Y 2
595	9	34 49.59	" Y 2	3 0 50.28	" Y 1
443	8	26 42.82	" Y 2	2 32 52.04	" Y 1
376	9	23 19.69	" Y 2	2 29 34.46	" Y 1
287	8.5	17 22.35	" Y 1	2 35 56.18	" Y 1
196	9	12 8.52	WEISSE, Catalogue.	2 17 49.13	WEISSE, Catalogue.
212	8.5	12 58.72		2 15 22.10	
90	9	0 5 54.99		+ 2 36 54.41	

* The places of the stars marked Y have been determined by observations with the Transit and Mural of the Observatory, made and reduced by Professor YARNALL.

FROM A LETTER OF PROFESSOR ENCKE TO THE ÉDITOR.

Berlin, 1858 November 2.

I HAVE not yet sent you our observations of the planet discovered at Albany, or of the last comet, which have been carefully followed, in spite of the Great Comet and its brilliancy. There are doubtless still later ones than those which I send; but since neither of my assistants are now at hand, I will send these lines without longer delay, and postpone the other observations.

Dr. BRUNNS has copied the accompanying observations for me.

FIFTY-FIFTH ASTEROID.

1858.	Berlin M.T.	α	δ
Oct. 1	16 ^h 10 ^m 25.0	7 ^h 55 ^m 11.9	+2° 49' 54.1
1	10 59 12.2	7 16 40.8	2 44 54.2
6	10 12 16.9	6 49 27.7	2 41 26.4
7	8 50 10.7	6 36 55.1	+2 39 43.1

COMET 1858 VIII (TUTTLE).

1858.	Berlin M.T.	α	δ
Oct. 6	10 ^h 42 ^m 2.0	341° 40' 18.7	+26° 18' 0.1
7	12 4 10.6	338 13 10.6	+23 13 5.5

These, though few, may at least serve to show both that we think of you, and that we do not neglect American discoveries.

ENCKE.

PHYSICAL APPEARANCES OF THE GREAT COMET OF 1858.

IN Mr. LEVERRIER'S *Meteorological Bulletin*, Mr. CHACORNAC of the Imperial Observatory of Paris, and Mr. DONATI of Florence, have given results of their physical observations of the late magnificent comet. These observations are of so much interest and importance, that I have been prompted to prepare a digest of the phenomena observed.

June. At the time of the first detection of the comet by Mr. DONATI, June 2, he describes it as a small nebosity about 3' in diameter, and of uniform brightness. This appearance continued until the month of August, in the course of which a sensible condensation of the light toward the center became manifest, though not sufficiently definite to be called a nucleus.

September 3. The comet, according to Mr. DONATI, first became visible to the naked eye; and with the aid of low powers, a tolerably defined nucleus was perceptible, having a mild light, and being elongated in a direction perpendicular to the tail, which was about 2° long. Under high powers, the nucleus almost disappeared.

After this date, the diameter of this supposed nucleus went on decreasing, and its form, at first elliptic, was modified: it became more and more sharply defined; its light grew more brilliant, and the surrounding nebosity seemed to dilate.

September 4. The comet first seen at Albany with the naked eye, the weather having been cloudy since August 24. Mr. SEARLE estimated the appearance as being like that of a star of the third magnitude, with a very slight tail.

September 10. The very valuable and thorough observations of Mr. CHACORNAC commenced. This astronomer describes the nucleus as then being round and brilliant, "and like a planetary disc with the faint coma surrounding it," with nucleus well defined in the comet-seeker with a power of 100. He employed powers varying from 60 to 770, which gave to the comet very different appearances; the higher

showing a nebula with a concentration at the center, while to the naked eye the nucleus and coma together appeared at least equal in brilliancy to the brightest star in the tail of the Great Bear. Yet photometric measurement showed that the brightest part of the nucleus was inferior in brilliancy to the star ν *Ursæ Majoris*. No definite boundary to the coma could be recognized, and the comet showed no traces of polarized light.

September 11. Mr. CHACORNAC saw no essential change, except that the nucleus was somewhat brighter. The southern part of the coma was more brilliant than the northern, and its total intensity was but a small fraction of that of the nucleus.

Counsellor SCHWABE of Dessau, using a six-foot telescope and a power of 30, saw the nucleus as disc-like and yellowish, but well defined only on the side toward the tail, which was white, striped, curved somewhat to the left (astron. eyepiece), and brighter on the convex side; its light varying. From the left side of the head proceeded an extremely faint short secondary tail, making with the axis of the tail proper an angle of 45° or 50°. The next day it had disappeared, and it was not visible again. A power of 96 diminished the apparent size of the nucleus, and showed a luminous stream, the hair-like stripes of which curved backwards and united with the tail, or rather seemed to pierce it, in the manner described by BESSEL for Halley's comet, and subsequently observed in others. With a power of 144, the nucleus became a point: and with one of 216, it was resolved into a dense mass of light.

From this date to the 20th September, Mr. SCHWABE remarked no essential change, other than the increase in size and brightness.

September 13. The brilliancy of the nucleus was, according to Mr. CHACORNAC, comparable to that of a star of the 7-8 magnitude.

September 14. The southern part of the coma, estimated by CHACORNAC as brighter than the northern. Seen with the large refractor, without an eyepiece, the comet showed traces of polarization, although only visible in that part of the tail nearest the nucleus.

September 17. Mr. PAPE of Altona considered the appearance as strikingly similar to that of the comet of 1744 as described and depicted by HEINSIUS, and to that of Halley's comet in 1835 as described by BESSEL. With a high power, the nucleus seemed to him elongated toward the vertex of the coma.

September 19. Mr. CHACORNAC noticed a change in the appearance since the 14th; the coma having been brighter on both sides, although the southern was the brighter of the two. The apparent diameter of the nucleus had increased; and even with the lowest powers it appeared surrounded with a small nebulosity, more extended in the direction opposite to the tail. With a power of 770, the nucleus did not completely lose its planetary appearance: the part nearest the sun appearing, however, most nebulous. The nucleus was no longer in the center of the coma, but nearer to the northern side; although the boundaries of the nebulosity were too ill defined to permit this difference to be measured.

The brightest part of the nucleus, compared with the star 12 *Can. Venat.*, was found about equal in brilliancy to the fainter component. That portion of the coma in the axis of the tail was clearly less luminous than the rest. No considerable quantity of polarized light was detected on careful comparison.

September 20. Professor PETERS and Mr. PAPE agreed in recognizing the appearance of a stream proceeding from the nucleus, in the direction opposite that of the tail. The nucleus appeared sharply bounded, on the side toward the tail, for about 240° of its circumference; but on the side toward the coma, for about 120°, it appeared shaded off, looking as though the material of the nucleus flowed gradually into the coma, and then bending round to the right and left, streamed off to form the tail. The direction of this stream formed with that of the tail, produced on the other side, an angle of about 30° (to the right in the astron. telescope).

September 21. The same appearance was recognized by Messrs. PETERS and PAPE, except that the inclination to the right appeared greater, so that the angle between the direction of the stream and the axis of the tail produced amounted to about 45°.

Mr. SCHWABE represents the head (power 96) as being somewhat compressed on the apparent right side, which appeared flatter but brighter than the other. The nucleus was almost a lune, and washy on the side toward the sun: from this diverged several distinctly curved beams; and close to its convex side (toward the tail) was a very dark shadowlike spot.

September 22. Mr. SCHWABE saw the nucleus expanded like a fan, and directed somewhat toward the (apparent) right of the head. In this fan were several brighter streams; which, however, a companion was only able to see upon the right side.

On the same night, the out-streaming appeared to Messrs. PETERS and PAPE much more distinct than on the previous evening. It was very manifest in the bright twilight, before any trace of the tail became visible; and later, when a part of the coma and of the tail was recognized, the comet appeared greatly to resemble one of the drawings of the comet of 1744 given by HEINSIUS. The direction of the stream seemed to coincide with that of the prolonged axis of the tail, and consequently to have moved half a quadrant to the (apparent) left. The tail was on the (telescopically) right side so much brighter than on the other, that in the twilight only this side was visible at first.

The division of the tail into two parallel branches was especially noticeable.

The excess of brightness of the southern edge of the tail, so very striking on this night, became subsequently one of the most

prominent characteristics of the tail, and, together with the curvature towards the south and great width at its extremity, were the chiefly noticeable features to the ordinary observer. From about the 20th September on, these features attracted especial attention; the whole southern, or convex, side of the tail being exceedingly brilliant and sharply defined, while the concave side faded so gradually that its boundary could scarcely be distinguished. The general aspect of the comet to the naked eye was that of a huge plume or ostrich feather, strongly bowed by the wind.

September 23. Mr. CHACORNAC found the nucleus enveloped by three concentric semicircles, differing in brightness. The two most luminous were intersected by corresponding radii, and alternately bright and dark. The nucleus itself was not precisely in the center of figure of these envelopes, but was nearer to the northern edge, which was the fainter. Finally very close to the nucleus a fourth envelope was visible, brighter than any of the preceding ones, and detaching itself in a spiral form.

On this evening, the nucleus appeared to Mr. DONATI round and tolerably well defined, its light resembling that of *Mars*.

September 25. At 4½ a.m. the envelope which CHACORNAC had seen so near the nucleus on the 23d, had become separated from it by a considerable interval, and a fifth envelope was seen just detaching itself. Traces of polarization were also perceptible to him.

Between this date and October 8, two more envelopes, the *sixth* and *seventh* according to CHACORNAC, were thrown off from the nucleus; the *sixth* being quite brilliant, and showing light clearly polarized. The tail was estimated by Mr. LOGAN, of Sacramento, as 8° or 9° in length.

September 26. The tail, according to Mr. LOGAN, was from 10° to 11° long.

September 28. By the rotation of a Nicoll's prism placed in the focus of the great telescope, Mr. CHACORNAC found that great variations in the light could be produced; the minimum being when the small diameter, and the maximum when the large diameter, of the prism was parallel to the axis of the tail. The tail, according to Mr. LOGAN, was 17° or 18° long.

September 30. From the 23d of September to this date, Mr. CHACORNAC estimated the nucleus as being somewhat nearer to the southern than to the northern limit of the envelopes; although after October 2 the reverse was the case, the nucleus appearing to be closer to the northern edge, and this side of the envelopes becoming more luminous and more extended, the fourth or spiral envelope seeming, like the rest, by its enlargement, to form the luminous part of the head.

Mr. DONATI also had noticed what he calls a luminous *aureole* around the nucleus, with a dark semicircle surrounding another bright *aureole* within. These aureoles were probably respectively the first three envelopes of Mr. CHACORNAC, and the *fourth* and *fifth*. DONATI estimated the tail as 25° in length, and found the diameter of the nucleus to be 3".

October 1. Length of tail, according to DONATI, 27°.

October 2. Length of tail, according to TOOMER, 26°; max. breadth, 4°.
" " " SEARLE, 24; " " 5.

October 3. Diameter of nucleus, according to DONATI, 2".9.

October 5. Length of tail, according to DONATI, 40°.
" " " TOOMER, 22; max. breadth, 5°.
" " " SEARLE, 27; " " 6.

October 6. Length of tail, according to TOOMER, 26°; max. breadth, 6°.
" " " SEARLE, 30; " " 6.

October 6. Four small luminous patches seen by CHACORNAC upon the surface of the sixth envelope; its brilliancy being otherwise uniform.

October 7. The seventh luminous envelope was perceptible around the nucleus, although too close to it to permit Mr. CHACORNAC to make any measures.

October 8. The seventh envelope, detached from the nucleus, clearly distinguishable and very bright. Its diameter, perpendicular to the dark axis of the tail, was $20''.45$; and its eccentricity relative to the nucleus, measured on this same diameter, was $3''.38$.

October 9. A small dark triangular point was remarked by Mr. CHACORNAC upon the seventh envelope, nearly midway upon a radius-vector inclined about 45° to the axis of the tail. In the large telescope it resembled an opening in the envelope, which, as well as the nucleus, appeared unsymmetrical. The light seemed distributed uniformly on the two sides of the radius-vector through this dark point; and at the outer margin of the envelope, it formed a protuberance in the direction of the radius prolonged.

On the 4th and 5th October, DONATI also saw what seems to have been a similar spot upon the sixth envelope. It was also observed by Professor AMICI, who noted a bright spot like a second nucleus within it.

October 9. Mr. TOOMER, in Albany, estimated the length of the tail as 30° , and the maximum breadth as 10° . Mr. SEARLE made the length to be 33° , but called this a poor estimate. Mr. THOMAS M. LOGAN, in Sacramento, California, estimated the length at 30° .

October 10. Mr. SEARLE, at the Dudley Observatory, noticed not only that the nucleus was eccentric in reference to the coma, but also that the intense brilliancy from the nucleus extended about twice as far on the northern as on the southern side. The length of the main portion of the tail, according to his estimate, was 37° : one of the faint branches, however, extended to the length of 43° . The breadth at δ *Serpentis* was $4\frac{1}{2}^\circ$, the bright portion tapering from that point to the extremity, where the breadth, including faint branches, was roughly estimated at 10° .

Mr. TOOMER estimated the length as 40° , and the maximum breadth as 16° .

October 12. The same dark point visible to Mr. CHACORNAC, which he had observed on the 9th; its position not being sensibly changed, but it was larger and not so black. The unequal light of the sixth and seventh envelopes was strongly condensed in the direction of the radius-vector passing through the dark point; and each of these envelopes presented, in this direction, a distinct protuberance. The nucleus and the envelopes had both diminished in brilliancy.

October 15. The eighth envelope had separated from the nucleus. (On the 14th, Mr. CHACORNAC had observed a well-marked spiral appearance.) Its diameter, perpendicular to the axis of the tail, was $24''$; and the smallest radius-vector, $6''.5$. The eccentricity had increased, in the direction noticed since October 8 for the seventh envelope, to such an extent that for this eighth envelope it was more than double the shortest radius-vector. The length of the radius-vector, parallel to the tail, was $11''.75$.

Professor GOVI found in the light from September 27 to October 16, strong marks of polarization, the plane coinciding nearly with that of the axis of the tail.

October 15. Length of tail, according to TOOMER, 8° ; breadth, 1° . Mr. SEARLE thought that he could distinguish signs of a tail 20° long and $3\frac{1}{4}$ broad. The comet was very low, and the moonlight strong.

The want of any suitable instrument necessarily precluded any observations either of position or of the structure of the nucleus, at the Dudley Observatory; but from the 2d to the 15th October, careful drawings of the form and extent of the tail were made by Messrs. TOOMER and SEARLE, upon stellar charts. There are in all thirteen such drawings; which have been placed in the hands of Professor PEIRCE, for comparison with his formulas. G.

FIFTY-FIFTH ASTEROID.

THIS planet, discovered on the same night with the last one of Mr. GOLDSCHMIDT, presents a case, like the recent one of the double *Daphne*, where a rigorous determination of the numerical order of discovery would be attended with difficulty, and where consequently the order of notation ought to be subjected to arbitrary rule. The fact that the planet of

Mr. GOLDSCHMIDT is already widely known as the fifty-fourth, furnishes a sufficient reason why the planet of Mr. SEARLE should be numbered as the fifty-fifth.

Mrs. DUDLEY, having been invited by Mr. SEARLE to select a name for this planet, has proposed the name *Pandora*, the apt significance of which will be obvious to all. G.

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FIFTY-FIFTH ASTEROID.

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NO. 21.

ON THE APPROACHING RETURN OF BIELA'S COMET.

BY PROFESSOR J. S. HUBBARD.

I SEND herewith an approximate ephemeris of each nucleus of Biela's Comet for the approaching return to the perihelion ; regretting that many serious interruptions have delayed the work thus far, and finally prevented me from giving it the desired completeness.

Perhaps it will be remembered that after the last appearance in 1852, it was found impossible to decide, either from the observations or the physical phenomena, *which* nucleus corresponded with that known as the primary in 1846 ; and that the only approach I could find to a determining consideration resulted from a study of the mutual distances of the two bodies in 1846. I found, namely, that, in case of identity of the principal nucleus of this year with either the preceding or following in 1852, there was a maximum distance apart at the former perihelion, and a minimum about 500 days on either side of it ; that these minima were not equal, but, in the one case, the smaller minimum was *before* the perihelion, and in the other case was *after* it. Moreover, by reason of the difference of mean motions in either case, these minima are forever *minima minimorum* ; and therefore the original separation must have occurred near the one which preceded the perihelion in 1846, i. e. in the latter part of 1844. Now it is far more likely that the two comets, starting with the lesser minimum, should pass the greater without mutual disturbance, than the converse ; and in the absence of other considerations, I am justified in adopting the corresponding hypothesis, that *the principal nucleus in 1846 is identical with the one which preceded in 1852.*

In accordance with this hypothesis, my Elements III and B, given in a preceding number of this Journal⁽¹⁾, require the substitution of $\Delta\mu = +0''.36086$ and $\Delta\mu' = +0''.29396$ in

order to represent the observations in 1852, thus increasing slightly the sum of squares of residuals in 1846. With the definite working elements thus obtained, I have computed, by Encke's method, and in all strictness, the perturbations of the rectangular ecliptic coördinates to the tenth place of decimals, from the perihelion in 1846 to April 17, 1858, the close of the principal division of the work, and the epoch where it becomes necessary to proceed by shorter intervals. As time is wanting for the remainder of the computation, and as the amount of perturbation from thence to the perihelion is doubtless no greater than the effect of present unavoidable error of elements, and will certainly be inappreciable in searching for the comets, I have simply brought forward the elements from that point as below, and so computed the sub-joined ephemerides.

It is earnestly to be hoped that, notwithstanding the unfavorable circumstances attending this visit to the perihelion, some few observations will be obtained, sufficient to decide the question of identity of the nuclei, and thus greatly facilitate future investigation.

It must be added that, if the present hypothesis should prove to be the incorrect one, the two comets will still be in nearly the same general position, only their relative places will be reversed.

1859 May 24.0 Greenwich M.T. : M. Equinox 1859.0.

NUCLEUS I.			NUCLEUS II.		
359° 56'	8''46	<i>M</i>	0° 8'	8''62	
245 43	9.03	Ω	245 42	52.72	
223 50	31.02	ω	223 50	53.53	
12 23	44.67	<i>i</i>	12 23	41.35	
48 53	39.53	φ	48 53	17.17	
531''	.87476	μ	532''	.01878	

(1) *Astronomical Journal*, III, 90, 93; and IV, 4.

EPIHEMERIS.

Greenwich M.T.		I.			II.		
1859		α	δ	$\log \Delta$	α	δ	$\log \Delta$
		^h ^m ^s	[°] [']		^h ^m ^s	[°] [']	
March	23	1 10 28	+11 36.7	0.3106	1 12 29	+11 38	0.3369
	27	23 3	12 23.4	.3342	25 11	12 28	
	31	36 9	13 13	.3275	38 25	13 17	.3237
April	4	49 49	14 2	.3206	52 13	14 6	
	8	2 4 5	14 50	.3137	2 6 38	14 53	.3098
	12	18 57	15 36	.3065	21 39	15 39	
	16	34 29	16 20	.2994	37 21	16 23	.2955
	20	50 40	17 1	.2922	53 41	17 3	
	24	3 7 31	17 39	.2851	3 10 42	17 40	.2812
	28	25 2	18 12	.2780	28 23	18 12	
May	2	43 12	18 40	.2712	46 43	18 38	.2673
	6	4 2 1	19 1	.2645	4 5 41	18 59	
	10	21 24	19 16	.2582	25 12	19 12	.2544
	14	41 18	19 23	.2523	45 13	19 18	
	18	5 1 40	19 22	.2469	5 5 41	19 15	.2432
	22	22 22	19 12	.2420	26 28	19 3	
	26	43 19	18 54	.2378	47 29	18 43	.2345
	30	6 4 25	18 26	.2345	6 8 37	18 14	
June	3	25 33	17 50	.2320	29 44	17 36	.2289
	7	46 34	17 5	.2305	50 43	16 50	
	11	7 7 24	16 13	.2300	7 11 31	15 56	.2274
	15	27 56	15 14	.2305	31 59	14 56	
	19	48 4	14 8	.2322	52 2	13 50	.2302
	23	8 7 45	12 57	.2351	8 11 37	12 38	
	27	26 56	11 43	.2390	30 41	11 23	.2376
July	1	45 33	10 25	.2440	49 11	10 5	
	5	9 3 34	9 5	.2499	9 7 5	8 45	.2491
	9	20 59	7 44	.2568	24 22	7 24	
	13	37 48	6 22	.2645	41 3	6 3	.2642
	17	54 0	5 0	.2728	57 7	4 42	
	21	10 9 37	+ 3 40	0.2818	10 12 36	+ 3 22	0.2821

ON THE THEORY OF THE COMET'S TAIL.

BY BENJAMIN PEIRCE,

PERKINS PROFESSOR OF ASTRONOMY AND MATHEMATICS IN HARVARD UNIVERSITY.

POSTPONING to the close of this article all consideration of previous investigations, I propose to give the mathematical development of that hypothesis which appears to be most accordant with the observed phenomena, and compare it with the valuable observations upon the tail of the Great Comet of 1858 which were made under the supervision of Dr. GOULD, the Director of the Dudley Observatory, by his assistants Mr. SEARLE and Mr. TOOMER.

Each particle of the matter which composes the tail is supposed to move in a hyperbolic orbit, with the sun in the focus of the opposite branch, under the influence of a repulsive force emanating from the sun, and decreasing by the law of the inverse square of the distance. The mutual action of the particles is neglected, as well as the action of the comet itself,

and even the effect of any explosive force at the moment of separation from the comet. The radius of the comet's sphere of action is also neglected in the first approximation; so that the particle, at the instant of leaving the comet, moves in the hyperbola which is tangential to the path of the comet, with a velocity identical with that of the comet. The area described by the radius-vector of each particle of the tail is always the same, therefore, with that which is described in the same interval of time by the comet itself. The formulas are arranged for a parabolic motion of the comet, which is sufficiently precise for all the purposes of this investigation, although they might easily have been adapted to the more general case of an elliptic orbit.

Let the following notation be adopted :

r_0 = the radius vector of the comet at the instant when the particle leaves it ;
 v_0 = the corresponding true anomaly of the comet ;
 k = the Gaussian constant ;
 P = the comet's perihelion distance, so that
 $r_0 = P \sec^2 \frac{1}{2} v_0 = P (1 + \tan^2 \frac{1}{2} v_0)$;
 t_0 = the instant at which the particle leaves the comet, so that
 $kt_0 = P^{\frac{3}{2}} \sqrt{2} (\tan \frac{1}{2} v_0 + \frac{1}{3} \tan^3 \frac{1}{2} v_0)$;
 a = the semi-transverse axis of the hyperbolic orbit of the particle ;
 b = its semi-conjugate axis ;
 η = the hyperbolic angle of eccentricity, so that
 hyperbolic sine of $\eta = \text{Sin } \eta = \frac{b}{a}$;
 e = the hyperbolic eccentricity = $\text{Cos } \eta$;
 $-\mu$ = the excess of the repulsive force exerted upon the particle by the sun, over the gravitation towards the sun, of which the force of gravitation is the unit ;
 $n = k \mu^{\frac{1}{2}} a^{-\frac{3}{2}}$;
 r = the radius-vector of the particle ;
 q = its angular distance from the axis directed to the comet's perihelion ;
 ϖ = the corresponding angle for the perihelion of the particle ;
 ψ = the hyperbolic eccentric anomaly of the particle, so that
 $r \sin (q - \varpi) = b \text{Sin } \psi$,
 $r = a (1 + \text{Cos } \eta \text{Cos } \psi) = a (1 + e \text{Cos } \psi)$;
 τ = the instant of the passage of the particle through its perihelion, so that
 $n(t - \tau) = \psi + e \text{Sin } \psi = \psi + \text{Cos } \eta \text{Sin } \psi$;
 $h = 2 \left(\frac{1}{\mu} + 1 \right)$;
 $h_1^2 = \frac{2h}{\mu}$;
 $h_1 = 1 + \frac{2}{\mu} = h - 1$.

The elements of the orbit of any particle can then be derived from the equations

$$\begin{aligned}
 a &= \frac{r_0}{h}, \\
 \text{Sin } \eta &= h_1 \cos \frac{1}{2} v_0, \\
 \text{Cos } \psi_0 &= h_2 \text{Sec } \eta, \\
 h \sin (q_0 - \varpi) &= \text{Sin } \eta \text{Sin } \psi_0, \\
 q_0 &= v_0, \\
 n(t_0 - \tau) &= \psi_0 + e \text{Sin } \psi_0.
 \end{aligned}$$

From the elements thus determined, the ephemeris is computed by means of the preceding formulæ. The values of the logarithms of the constants h , h_1 , h_2 and $k\sqrt{\mu}$ for different values of μ , are given in the following table :

$-\mu$	$\log h$	$\log h_1$	$\log h_2$	$\log (k\sqrt{\mu})$
.5	.77815	.69010	.77815	8.08507
1.	.60206	.45154	.47712	8.23558
1.5	.52288	.32391	.36798	8.32367
2.	.47712	.23856	.30103	8.38610
2.5	.44716	.17512	.25527	8.43455
3.	.42597	.12494	.22185	8.47414
3.5	.41017	.08356	.19629	8.50761
4.	.39794	.04846	.17609	8.53661
5.	.38021	.9.99113	.14613	8.58506
6.	.36798	9.94543	.12494	8.62465
7.	.35902	9.90747	.10914	8.65813
8.	.35218	9.87516	.09691	8.68712
9.	.34679	9.84679	.08715	8.71270
10.	.34242	9.82172	.07918	8.73558
15.	.32906	9.72700	.05436	8.82362
20.	.32222	9.66111	.04139	8.88609
40.	.31175	9.51060	.02119	9.03661
100.	.30535	9.30319	.00860	9.23558

In applying these formulas to the Great Comet of 1858, I shall adopt the elements and formulas given by WATSON on page 165 of the Journal, with the omission of the eccentricity ; so that they become

Time of perihelion passage = 1858 Sept. 29.7364 Wash. M.T.

$$\log P = 9.76230$$

$$x = r [9.98863] \sin (45^\circ 52' 42'' + q),$$

$$y = r [9.37536] \sin (207^\circ 29' 16'' + q),$$

$$z = r [9.99884] \sin (134^\circ 54' 25'' + q),$$

in which the rectangular axes refer to the mean equinox and equator of 1858.0.

As an application of these formulas, I will determine the elements of the particle which leaves the comet at the date Sept. 24.7364 with the repulsive force $-1\frac{1}{2}$.

t_0	— 5.0
$\log t_0$	0.69897 n
$\log (t_0 P^{-\frac{3}{2}})$	1.05552 n
$v_0 = q_0$	— $15^\circ 38' 38''$
$\frac{1}{2} v_0$	— $7^\circ 49' 19''$
$\sec^2 \frac{1}{2} v_0$	0.00812
r_0	9.77042
a	9.24754
$\text{Sin } \eta$	.31985

b	9.56739
$\text{Cos } i = e$	.36466
$\text{Cos } \psi_0$	.00332
$e \psi_0$ in hyp. table	— $7^\circ 4' 30''$
$\text{Sin } \psi_0$	9.09379 n
$\text{sin } (q_0 - \varpi)$	8.89076 n
$q_0 - \varpi$	— $4^\circ 27' 35''$
ϖ	— $11^\circ 11' 3''$
$\text{Cos } i, \text{Sin } \psi_0$	9.45845
$\text{Cos } i, \text{Sin } \psi_0$	— .2874
ψ_0	— .1238
$n(t_0 - \tau)$	— .4112
$\sqrt{a}$	9.62377
n	9.45231
$n(t_0 - \tau)$	9.61405 n
$t_0 - \tau$	.16174 n
$t_0 - \tau$	— 1.4512
τ	Sept. 26. 1876

The place of this particle at the date October 10.290 is constructed in the following form :

$t - \tau$	14.1024
$t - \tau$	1.11931
$n(t - \tau)$	.60162
$n(t - \tau)$	3.9959

First Hyperbola.		Second Hyperbola.
ψ	1.0	1.1
$e \text{ Sin } \psi$	2.9959	2.8959
$e \text{ Sin } \psi$	.47652	.46178
$\text{Sin } \psi$	.11186	.09712
$e \psi$	$52^\circ 17' 56''$	$52^\circ 21' 12''$
ψ	1.0746	1.0480
Error	.0746	— .0520

(To be continued.)

For the third Hyperbola,

$$\psi = 1.0480 + \frac{520(1.0746 - 1.0480)}{520 + 746} = 1.0589$$

$e \text{ Sin } \psi$	2.9370
$e \text{ Sin } \psi$	.46790
$\text{Sin } \psi$	.10324
$e \psi$	$51^\circ 44' 48''$
ψ	1.0589
Error	0
$\text{Cos } \psi$	.20821
$e \text{ Cos } \psi$	.57287
Gauss. $\log hr(1 + e \text{ Cos } \psi)$	.10291
r	9.92332
$r \text{ sin } (q - \varpi)$	9.67063
$\text{sin } (q - \varpi)$	9.74731
$q - \varpi$	$33^\circ 58' 41''$
q	$22^\circ 47' 38''$

The substitution of these values of r and q in WATSON'S coördinate formulas, combined with the solar coördinates for the date, which are

$$\begin{aligned} X &= - .95215, \\ Y &= - .27348, \\ Z &= - .11868, \end{aligned}$$

gives for the geocentric right-ascension and declination of the particle

$$\begin{aligned} \text{AR} &= 245^\circ 49', \\ \text{Dec} &= +23^\circ 0'. \end{aligned}$$

The observations of Messrs. SEARLE and TOOMER were made upon the nights of Oct. 2, 5, 6, 8, 9, 10 and 15. They were made by mere estimation of position among the stars, and not by exact measurement. My examination of them has led me to regard them as being very valuable; and it is important that they should be published in the same form of diagrams in which they have been submitted to me, in order to appreciate them, to understand the criticisms to which they may be subjected, and to estimate the remarkable conclusions which can be drawn from them.

ELEMENTS AND EPHEMERIS OF THE GREAT COMET OF 1858.

BY GEORGE SEARLE,

ASSISTANT AT THE DUDLEY OBSERVATORY.

THE following three normal places, at intervals of 62 days, have been deduced by the aid of Dr. BREXNOW'S elliptic elements : the first is from eight observations at Berlin, Florence, Padua, and Vienna ; the second, from six at Washington and Ann-Arbor ; the third, from nine at Bonn, Göttingen, Markree, Washington, and Ann-Arbor.

Washington M.T.	α	δ
1858 June 13.5	$141^\circ 22' 48.3$	$+25^\circ 1' 57.6$
Aug. 14.5	$152^\circ 23' 29.7$	$+31^\circ 26' 8.3$
Oct. 15.5	$242^\circ 34' 33.7$	$-14^\circ 39' 40.4$

They are freed from parallax and aberration, and referred to the mean equinox 1858.0 ; and furnish the following elements :

$T = \text{Sep. 29.75230}$ Washington M.T.
 $\pi = 36^\circ 12' 21.4''$
 $\Omega = 165^\circ 18' 46.2''$
 $i = 116^\circ 57' 46.1''$
 $q = 85.21$
 $\log q = 9.7622362$
 $\log a = 2.245944$
 Period = 2338 years.

} Mean Equinox 1858.0.

$$\log \alpha = 0.3161308$$

$$\log \beta = 7.21656$$

$$\log \gamma = 0.0002859$$

The places are represented as follows :

$$\begin{array}{rcl}
 & & \text{C.}-0. \\
 \beta & & \beta \\
 -0.2 & & 0.0 \\
 +0.6 & & 0.0 \\
 -0.2 & & +0.4
 \end{array}$$

These elements give the following ephemeris for Washington Mean Noon, and the mean equinox 1858.0 :

EPHEMERIS OF THE GREAT COMET OF 1858.

1858	α	δ	$\log \Delta$	1858	α	δ	$\log \Delta$
June 7	141 13 53.5	+24 20 42.5	0.3958	July 24	118 38 42.4	+28 52 18.3	0.3705
8	14 22 8	27 16.4	3963	25	146 51 41.6	28 58 28.9	3686
9	15 11.8	33 45.1	3968	26	147 4 56.4	29 4 43.8	3666
10	16 20.2	40 8.9	3973	27	18 27.0	11 3.3	3645
11	17 47.6	46 28.1	3977	28	32 13.5	17 27.4	3623
12	19 34.0	52 42.9	3981	29	147 46 16.4	23 56.4	3600
13	21 38.8	24 58 53.6	3984	30	148 0 35.7	30 30.5	3576
14	24 1.9	25 5 0.3	3987	31	15 12.0	37 10.1	3551
15	26 43.3	11 3.2	3990	Aug. 1	30 5.8	43 55.3	3526
16	29 42.7	17 2.6	3993	2	148 45 17.0	50 46.2	3500
17	32 59.8	22 58.6	3995	3	149 0 46.3	29 57 43.1	3473
18	36 34.1	28 51.5	3996	4	16 34.3	30 4 46.4	3445
19	40 25.0	34 41.6	3996	5	32 41.3	11 56.1	3416
20	44 32.2	40 28.9	3996	6	149 49 7.7	19 12.7	3385
21	48 56.7	46 13.6	3997	7	150 5 54.2	26 36.4	3353
22	53 38.7	51 56.0	3996	8	23 1.5	34 6.7	3321
23	141 58 38.0	25 57 36.3	3996	9	40 30.2	41 44.8	3288
24	142 3 52.5	26 3 14.5	3995	10	150 58 20.4	49 30.6	3254
25	9 21.4	8 51.0	3993	11	151 16 33.4	30 57 24.3	3219
26	15 7.3	14 25.8	3991	12	35 10.0	31 5 26.2	3182
27	21 10.8	19 59.2	3988	13	151 54 10.9	13 36.4	3144
28	27 27.9	25 31.4	3985	14	152 13 36.9	21 55.3	3105
29	34 0.7	31 2.4	3981	15	33 29.4	30 23.0	3064
30	40 49.5	36 32.6	3977	16	152 53 49.7	38 59.5	3022
July 1	47 54.2	42 2.1	3972	17	153 14 38.9	47 44.9	2979
2	142 55 13.0	47 31.0	3967	18	35 57.6	31 56 39.4	2934
3	143 2 47.2	52 59.5	3961	19	153 57 48.1	32 5 42.7	2888
4	10 36.9	26 58 27.8	3955	20	154 20 12.3	14 55.1	2840
5	18 42.2	27 3 56.0	3949	21	154 43 11.4	24 16.8	2791
6	27 1.4	9 24.3	3942	22	155 6 47.1	33 47.7	2741
7	35 35.7	14 53.1	3934	23	31 2.2	43 27.5	2688
8	44 25.0	20 22.5	3925	24	155 55 59.3	32 53 16.1	2634
9	143 53 29.6	25 52.7	3916	25	156 21 40.4	33 3 13.4	2578
10	144 2 48.2	31 23.8	3906	26	156 48 7.3	13 18.6	2520
11	12 21.7	36 56.1	3896	27	157 15 24.3	23 31.2	2460
12	22 9.9	42 29.8	3885	28	157 43 35.0	33 50.5	2398
13	32 12.3	48 5.1	3874	29	158 12 42.4	44 16.0	2334
14	42 29.3	53 42.1	3862	30	158 42 49.2	33 54 47.4	2268
15	144 53 0.9	27 59 21.2	3850	31	159 14 1.2	34 5 23.1	2200
16	145 3 47.3	28 5 2.5	3837	Sept. 1	159 46 23.6	16 2.3	2129
17	14 47.9	10 46.2	3823	2	160 20 0.4	26 43.3	2056
18	26 3.0	16 32.5	3809	3	160 54 57.9	37 23.7	1979
19	37 32.7	22 21.7	3794	4	161 31 24.3	48 2.1	1899
20	145 49 16.9	28 14.0	3777	5	162 9 18.7	34 58 35.0	1816
21	146 1 15.8	34 9.7	3760	6	162 48 57.1	35 8 59.0	1732
22	13 29.7	40 8.9	3742	7	163 30 25.9	19 11.9	1646
23	146 25 58.4	+28 46 11.7	0.3724	8	164 13 51.7	+35 29 10.1	0.1556

1858	α			δ	$\log \Delta$	1858	α			δ	$\log \Delta$
	$^{\circ}$	$'$	$''$	$^{\circ}$			$^{\circ}$	$'$	$''$	$^{\circ}$	
Sept. 9	164	59	26.3	+35 38 47.3	0.1460	Oct. 29	266	11	49.0	-38 31 59.8	9.9753
10	165	17	20.1	17 58.2	1362	30	267	22	10.1	39 25 43.6	9.9893
11	166	37	14.8	35 56 36.1	1260	31	268	29	21.8	40 15 24.1	0.0029
12	167	30	53.5	36 4 32.8	1154	Nov. 1	269	33	37.5	41 1 24.8	0161
13	168	27	0.7	11 38 8	1044	2	270	35	12.8	41 41 9.3	0290
14	169	26	23.3	17 43 5	0930	3	271	34	18.9	42 23 53.9	0415
15	170	29	17.0	22 34.9	0812	4	272	31	8.3	43 0 57.0	0535
16	171	36	0.1	25 57 5	0689	5	273	25	51.5	43 35 33.0	0653
17	172	46	52.4	27 31.2	0561	6	274	18	39.1	44 7 57.3	0767
18	171	2	15.4	27 5.5	0428	7	275	9	39.0	44 38 20.3	0877
19	175	22	31.5	24 8.2	0291	8	275	59	0.1	45 6 52.0	0984
20	176	48	3.9	18 15.1	0149	9	276	46	49.9	33 43.2	1088
21	178	19	16.1	36 8 56.1	0.0001	10	277	33	15.9	45 59 2.5	1190
22	179	56	33.3	35 55 35.5	9.9848	11	278	48	23.8	46 22 57.3	1288
23	181	40	20.0	37 32.9	9690	12	279	2	19.9	46 45 35.1	1383
24	183	30	58.6	35 11 1.7	9528	13	279	45	9.3	47 7 1.1	1476
25	185	28	49.2	31 41 9.5	9361	14	280	26	57.9	27 21.7	1566
26	187	34	9.5	34 6 57.9	9190	15	281	7	50.7	47 46 41.5	1654
27	189	47	14.4	33 21 23.0	9015	16	281	47	53.1	48 5 3.7	1739
28	192	8	9.2	32 26 13.5	8838	17	282	27	9.5	22 35.1	1822
29	194	36	49.5	31 20 14.8	8659	18	283	5	44.5	39 19.4	1902
30	197	13	9.1	30 2 11.0	8481	19	283	43	12.1	48 55 19.6	1980
Oct. 1	199	56	11.0	28 30 46.1	8305	20	284	20	16.7	49 10 38.2	2057
2	202	46	59.2	26 44 50.0	8133	21	284	56	45.7	25 17.2	2132
3	205	43	9.8	24 43 26.2	7969	22	285	32	41.5	39 21.2	2204
4	208	41	15.9	22 25 58.2	7814	23	286	8	6.5	49 52 51.6	2274
5	211	49	8.5	19 52 19.7	7674	24	286	33	3.1	50 5 50.5	2343
6	214	56	29.8	17 3 5.2	7552	25	287	17	33.9	18 20.3	2410
7	218	1	55.7	13 59 31.6	7451	26	287	51	40.7	30 22.7	2476
8	221	13	1.0	10 43 46.8	7376	27	288	25	23.6	41 59.7	2540
9	224	19	22.4	7 18 43.4	7327	28	288	58	46.4	50 53 12.6	2602
10	227	22	42.2	3 47 17.9	7308	29	289	31	49.9	51 4 3.0	2663
11	230	21	51.7	+ 0 11 47.0	7318	30	290	4	35.8	14 32.4	2722
12	233	15	50.4	- 3 16 36.7	7357	Dec. 1	290	37	4.8	21 42.5	2780
13	236	3	52.7	6 42 55.8	7422	2	291	9	18.4	34 34.1	2837
14	238	45	22.4	10 1 21.9	7511	3	291	41	17.8	44 7.7	2893
15	241	19	57.1	13 9 44.0	7621	4	292	13	4.2	51 53 25.4	2948
16	243	47	22.2	16 6 38.1	7746	5	292	14	38.4	52 2 27.8	3000
17	246	7	35.4	18 51 19.9	7885	6	293	16	0.8	11 15.8	3050
18	248	20	39.8	21 23 36.5	8034	7	293	47	12.7	19 50.3	3100
19	250	26	44.9	23 43 41.7	8189	8	294	18	11.6	28 12.4	3149
20	252	26	5.9	25 52 7.5	8349	9	294	49	7.2	36 22.7	3197
21	251	19	0.2	27 49 36.8	8511	10	295	19	51.6	44 21.0	3244
22	256	5	48.0	29 36 57.9	8674	11	295	50	28.1	52 9.0	3290
23	257	46	50.3	31 15 1.5	8836	12	296	20	57.2	52 59 47.4	3335
24	259	22	28.0	32 44 39.3	8996	13	296	51	18.6	53 7 16.7	3378
25	260	53	3.8	34 6 35.2	9154	14	297	21	34.2	14 37.3	3421
26	262	18	57.7	35 21 38.6	9209	15	297	51	44.3	21 49.5	3463
27	263	40	30.2	36 30 29.3	9161	16	298	21	48.3	28 53.7	3504
28	264	58	0.8	-37 33 43.7	9.9609	17	298	51	46.7	-53 35 50.3	0.3544

ON THE VARIABLE ALGOL, OR β PERSEI.

BY STILLMAN MASTERMAN.

A FEW American observations of the interesting variable star *Algol* have been published in Vol. V of the *Astronomical Journal*; which show that some interest has been awakened in this country for the investigation of the phenomena of the variable stars, or at least of this remarkable one. I commenced

a series of observations of the minima of *Algol* in December 1856, and have observed all which have been observable at my place of residence since that date, amounting to twelve in all, giving the times of minima as follows:

No. of Period.	Observed Minimum : Washington M.T.		Light Equation.	C.—O.
+ 7252	1856 December 7	8 ^h 57 ^m .89	+ 7.1	— 1.89
7275	1857 February 11	7 48.10	+ 0.1	— 1.17
7283	March 6	6 20.57	— 2.9	— 2.70
7349	September 11	11 58.49	+ 3.3	— 1.62
7357	October 4	10 24.60	+ 5.7	+ 0.80
7363	October 21	15 21.15	+ 6.9	— 3.75
7370	1857 November 10	17 3.57	+ 7.6	— 4.80
7418	1858 March 28	8 21.05	— 5.3	— 3.78
7477	September 13	12 9.15	+ 3.5	+ 2.45
7485	October 6	10 46.13	+ 5.8	— 5.90
7492	October 26	12 21.18	+ 7.2	— 0.28
+ 7501	1858 November 21	7 44.70	+ 7.6	— 4.40

The first column of the above small table gives ARGELANDER's number of periods since 1800, January 1; the second, the observed time of minimum; the third, the light-equation to be added to the observed time; and the fourth, the difference between the observed and computed time, according to ARGELANDER's elements given in No. 96 of the *Astronomical Journal*. Combining these observations on the supposition that the same errors are equally probable in all, I find the resulting mean period of variability to be $2^d 20^h 48^m 51^s.796$; which is somewhat greater than it should have been according to ARGELANDER's investigations.

Further to show the agreement of the several American

observations, I will give below those minima, observed during the autumn of 1856 and the years 1857 and 1858, so far as I am aware of such being performed, reduced to the epoch of the minimum of 1859 January 3, by assuming the period of $2^d 20^h 48^m 51^s$. In the first column of the annexed table is shown the number of period; in the second, the observed time of minimum; in the third, the observer: Mll. denoting Miss MITCHELL, at Nantucket; F. and S., Messrs. J. F. FLAGG and C. A. SCHOTT, at Washington; and M., the writer, at Weld, Franklin county, Maine; in the fourth, the light-equation; and in the fifth, the time reduced to the principal epoch.

No. of Period.	Observed Minimum : Washington M.T.		Observer.	Light Equation.	Reduced Time.
+ 7237	1856 October 25	8 ^h 33 ^m 50 ^s	Mll.	+ 7 ^m 8 ^s	1859 January 3 7 ^h 50 ^m 7 ^s
7242	November 8	16 50 18	F.	+ 7 37	8 2 49
7243	November 11	13 31 30	S.	+ 7 39	7 55 12
7251	December 4	12 5 0	S.	+ 7 15	7 57 30
7252	December 7	8 56 25	F.	+ 7 6	7 59 55
		8 57 53	M.		8 1 23
7260	1856 December 30	7 26 59	F.	+ 5 23	7 57 58
7275	1857 February 11	7 48 6	M.	+ 0 7	8 1 4
7283	March 6	6 20 34	M.	— 2 54	7 59 43
7349	September 11	11 58 29	M.	+ 3 16	7 59 42
7357	October 4	10 24 36	M.	+ 5 40	7 57 25
7363	October 21	15 21 9	M.	+ 6 56	8 2 8
7370	1857 November 10	17 3 34	M.	+ 7 38	8 3 18
7395	1858 January 21	9 19 24	S.	+ 2 55	7 53 10
7410	March 5	9 40 12	S.	— 2 46	7 55 32
7418	March 28	8 21 3	M.	— 5 19	8 3 2
7477	September 13	12 9 9	M.	+ 3 28	7 57 46
7485	October 6	10 46 8	M.	+ 5 49	8 6 18
7486	October 9	7 31 48	S.	+ 6 4	8 3 22
7492	October 26	12 21 11	M.	+ 7 10	8 0 45
+ 7501	1858 November 21	7 44 42	M.	+ 7 38	1859 January 3 8 5 5

Taking the simple mean of these numbers, we obtain for the epochal minimum +7516, 1859 January $3^d 7^h 59^m 40^s.7$ Washington mean time. By combining the period $2^d 20^h 48^m$

50^s with this epoch, I have obtained the annexed small ephemeris of minima visible at Washington during the year 1859, after having applied the correction for the light-equation.

EPIHEMERIS OF ALGOL-MINIMA, 1859.

Washington Mean Time.

	^h	^m		^h	^m		^h	^m		^h	^m
Jan. 3	7	55	June 18	15	18	Oct. 5	11	2	Nov. 20	11	1
20	12	50	July 11	13	47	8	10	51	Nov. 23	7	50
23	9	39	July 31	15	27	11	7	39	Dec. 6	15	55
Jan. 26	6	28	Aug. 3	12	15	25	15	42	9	12	44
Feb. 12	11	23	23	13	54	28	12	31	12	9	33
Feb. 15	8	13	Aug. 26	10	43	Oct. 31	9	20	15	6	22
Mar. 7	9	57	Sept. 12	15	34	Nov. 3	6	9	Dec. 29	14	27
10	6	46	15	12	22	11	17	24			
Mar. 30	8	30	Sept. 18	9	11	Nov. 17	11	13			

An increase of the number of observers of this most interesting of the variable stars is very desirable; and it is thought that could a few lovers of astronomical science, stationed in different parts of our country, undertake the ob-

servation of all the observable minima, a large part of those occurring during the hours of darkness and above the horizon at Washington might be represented by trustworthy records.

Weld, Maine, 1858 December 1.

ELEMENTS OF PANDORA,

By T. H. SAFFORD.

Washington Mean Time.

Epoch 1858 November 16.0, Mean Equinox.

$$\begin{aligned}
 M &= 9^{\circ} 0' 4.4 \\
 \omega &= 358^{\circ} 25' 16.5 \\
 Q &= 10^{\circ} 56' 36.8 \\
 q &= 8^{\circ} 6' 39.8 \\
 i &= 7^{\circ} 15' 48.6 \\
 \mu &= 12^{\circ} 52.729
 \end{aligned}$$

From observations at Washington : 1858 Sept. 13, Oct. 14, Nov. 13.

MR. SAFFORD also sent an ephemeris with these elements; but owing to the delay of this number, the period for which it was computed has now elapsed. G.

NOTICE BY THE EDITOR.

THE readers of the *Astronomical Journal* are probably aware of the embarrassments against which the Editor and publisher of this Journal has been contending during the past year, and which have resulted in the severance of his relations with the Dudley Observatory. An earnest desire to render this Journal solely and rigorously a means of advancing the science to which it is dedicated, rather than of promoting personal ends, has always prevented him from making it an organ for the expression of personal feeling, however strong the temptation and however justifiable such a course might be.

Recent irregularities in its publication now call upon the Editor to say in apology that by the sudden and violent expulsion of himself and his assistants from the Dudley Observatory, his papers and affairs were thrown into such confusion, and his strength so severely tasked, as to preclude proper attention to the affairs of this Journal. The preparation of his Reply to the severe attacks, made upon him under the signatures of nine of the Trustees of the Observatory, has demanded all his available energies; at the same time that the loss and misplacement of his papers has been such as to entail very great labor, even where the damage was in its nature reparable.

The first number of Vol. VI being in type at the time, it was issued at once, chiefly as an indication of continued vitality; and the present number is dated back to the close of the past year, for the sake of preventing misplacement and disorder. The index will follow before long; and unless unexpected obstacles should arise, the *Astronomical Journal* will continue to appear, as before its removal to Albany.

A serious difficulty has arisen, in consequence of the loss or destruction of one of the books in which the affairs of the Journal are registered, and of sundry communications intended for publication. Should the Editor have overlooked or forgotten any such papers, or any letters, he trusts that the circumstances of the case will be accepted as an adequate apology.

Letters addressed to Cambridge, Massachusetts, will always reach the Editor; and it is probable that his residence will be transferred to that city during the month of April.

B. A. GOULD JR.

ALBANY, February 1859.

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	“	11,	“	Comet 1858 VI,	“	Comet 1858 VIII.
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“ 180,	“	1,	“	“	“	“
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“ 182,	“	5,	“	$7^h 55^m 11^s.9,$	“	$7^{\circ} 55' 11''.9.$

T H E

ASTRONOMICAL JOURNAL.

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1861.

WITH deep regret I find myself compelled to suspend for the present the publication of the *Astronomical Journal*.

The heavy pecuniary sacrifice which it has entailed from the outset, and has continued to require, notwithstanding the announcement in No. 96, threatened at the commencement of the year to forbid its continuance beyond the sixth volume; and the last number of this volume was detained for several weeks to afford opportunity for announcing the discontinuance, should it prove unavoidable.

In February the prospect seemed brighter. I ventured to indulge a hope of going on as before, and the notice was omitted from the last number.

But no American is able to investigate or study now with the calmness which success requires. The energies of every citizen deserving of freedom are needed by his country, and those who may not fight against armed treason may at least assume the burden of those who do.

There is but one mode of laboring for Cisatlantic science to-day, namely, by struggling for the maintenance of civilization against barbarism in the Western Hemisphere. And this leaves little opportunity for astronomical research.

It is my fervent hope to resume the publication of the *Journal* at an early day, by commencing the seventh volume soon after the suppression of the present insurrection.

BENJ. APTHORP GOULD.

CAMBRIDGE, July, 1861.

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NO. 1.

ON THE MEAN PLACES FOR 1855.0 OF FORTY-EIGHT CIRCUMPOLAR STARS.

REPORT TO PROFESSOR A. D. BACHE, SUPERINTENDENT U. S. COAST SURVEY.

By B. A. GOULD Jr.

[Communicated by Authority of the Hon. Secretary of the Treasury.]

IN the Report of Mr. O. STRUVE upon the Chronometric Expedition for determining the difference of longitude between Altona and Greenwich, this astronomer gave an admirable catalogue of the mean right-ascensions of thirty-six circumpolar stars, of which no one was more than twenty-five degrees from the pole, or fainter than the sixth magnitude. This well chosen and accurately determined list has been for several years employed with great advantage in the telegraphic longitude operations of the Coast Survey; but numerous additional data now at hand, and especially the priceless *Radcliffe Catalogue*, promised an opportunity of still farther perfecting the right-ascensions given by STRUVE; while the length of time since the epoch 1840.0, adopted by him, augmented the influence of any erroneous determination of the proper motion. The method of star-signals, employed without exception in all the measurements of longitude by the Coast Survey, makes peculiar demands upon our constant knowledge of the adjustments of the small portable instruments employed, and requires especial watchfulness over the amount and rate of change in azimuth and collimation.

Moreover the telegraphic exchanges of star-signals, beginning sometimes soon after dark, suspended often for but a very short period, and frequently ending only with the approach of dawn, leave but little time for those observations from which the instrumental corrections are to be deduced; and it is thus rendered a matter of the highest importance that the culminations of the circumpolar stars employed should succeed one another throughout the sidereal day at intervals as short as possible. In most portions of the United States, the stars of STRUVE's list can be observed at both culminations; but even at Mobile and New-Orleans, the observation at the inferior transit is attended with serious difficulties for polar distances exceeding 20° .

These considerations have led me to prepare the present catalogue with considerable care; hoping that it may not only be found to answer its purpose so far as the telegraphic operations of the Coast Survey are concerned, but also be

serviceable as a standard catalogue of circumpolar stars for use by the larger and fixed instruments of observatories.

It contains the thirty-six stars whose right-ascensions for 1840.0 were determined by STRUVE; the four polar stars α , δ and 2 *Ursæ minoris* and 51 (Hev.) *Cephei*; and eight others so selected, that, while their average declination is 72° , only two of them are below the parallel of 70° , and that there can be no instant when some one of these stars will not pass the meridian within half an hour, either above or below the pole.

The average interval is of course fifteen minutes; and out of the 96 intervals, there are only four which exceed 24^m , and but six others which surpass 20^m . None of the stars are fainter than the 6 magnitude; their average magnitude being $4\frac{1}{2}$, according to ARGELANDER's *Uranometria Nova*.

For determining the places, the following catalogues have furnished materials:

1. BRADLEY's, as reduced by BESSEL to the mean equinox of 1755.0 in the *Fundamenta Astronomiæ*.
 2. PIAZZI's second catalogue of mean places for 1800.0.
 3. FEDORENKO's mean positions, for 1790.0, of LALANDE's circumpolar stars.
 4. GROOMBRIDGE's catalogue of circumpolar stars for 1810.
 5. ARGELANDER's mean places for 1830 of 560 stars.
 6. STRUVE: *Positiones Mediæ* for 1830, and the accompanying special catalogue.
 7. POND's catalogue of 1112 stars, for 1830.
 8. PETERS's observations at Pulkowa in 1840, published in OTTO STRUVE's Chronometric Expedition of 1844.
 9. AIRY's three Greenwich catalogues for 1840.0, 1845.0, & 1850.0.
 10. The *Radcliffe Catalogue* for 1845 of Mr. JOHNSON, who most kindly communicated the star-positions from the original MS.
- And for the close polar stars, the several volumes of the Greenwich and Radcliffe observations, and JOHNSON's catalogue of stars within six degrees of the north pole.

The Pulkowa constants of precession have been adopted throughout, and the fixed ecliptic of 1800 employed as the fundamental plane of reference; and it may not be amiss to give the values of the several fundamental quantities as computed for those years for which they were required.

Denoting by

ω_0 the obliquity of fixed ecliptic of 1800.0

ψ " total lunisolar precession from 1800.0

λ " total planetary precession from 1800.0

ω_1 " obliquity of mean ecliptic of date

m, n " coefficients of annual precession,

and using the values of z, z' and θ given by the equations

$$\tan \frac{1}{2}(z' + z) = \cos \frac{1}{2}(\omega'_0 + \omega_0) \tan \frac{1}{2}(\psi' - \psi)$$

$$\frac{1}{2}(z' - z) = \frac{1}{2}(\omega'_0 - \omega_0) \frac{\cotg \frac{1}{2}(\psi' - \psi)}{\sin \frac{1}{2}(\omega'_0 + \omega_0)}$$

$$\tan \frac{1}{2}\theta = \tan \frac{1}{2}(\omega'_0 + \omega_0) \sin \frac{1}{2}(z' + z),$$

in which the accented symbols refer to the respective dates, and the unaccented to the epoch 1855.0,—we have for three centuries the following values :

VALUES OF FUNDAMENTAL QUANTITIES.

Year.	ω_0	ψ	λ	ω_1	z'	z	$\tan \frac{1}{2}\theta$	m	n
	° ' "	° ' "	"	° ' "	° ' "	° ' "	"	"	"
1705	23 27 51.2863	-1 19 47.0593	-16.516	23 28 38.3319	359 2 10.602	359 2 16.646	n 7.8630076	+16.03523	+20.06890
1730	.2560	0 58 47.1172	11.768	26.7281	11 50.392	11 52.658	n 7.7838068	.04236	.06674
1755	.2349	37 47.3105	7.293	15.1197	21 30.111	21 28.599	n 7.6868764	.04948	.06458
1780	.2220	16 47.6394	3.120	28 3.5094	31 9.760	31 4.470	n 7.5619169	.05660	.06213
1790	.2207	-0 8 23.8089	-1.536	27 58.8649	35 1.601	34 54.799	n 7.4997604	.05945	.06156
1800	.2200	0 0.0000	0.000	54.2200	38 53.432	38 45.118	n 7.4272011	.06230	.06070
1805	.2202	+0 4 11.8963	+0.750	51.8975	40 49.343	40 40.273	n 7.3858039	.06372	.06027
1810	.2207	8 23.7872	1.488	49.5749	42 45.252	42 35.426	n 7.3400421	.06515	.05984
1815	.2217	12 35.6726	2.213	47.2522	44 41.158	44 30.576	n 7.2888851	.06657	.05941
1820	.2229	16 47.5526	2.927	44.9294	46 37.062	46 25.723	n 7.2308887	.06800	.05897
1825	.2245	20 59.4272	3.629	42.6066	48 32.963	48 20.869	n 7.1639374	.06942	.05854
1830	.2266	25 11.2964	4.318	40.2337	50 28.861	50 16.011	n 7.0847517	.07085	.05811
1835	.2290	29 23.1602	4.995	37.9608	52 24.756	52 11.151	n 6.9878370	.07227	.05768
1840	.2318	33 35.0185	5.661	35.6378	54 20.649	54 6.288	n 6.8628937	.07370	.05725
1845	.2349	37 46.8715	6.314	33.3147	56 16.549	56 1.423	n 6.6867978	.07512	.05682
1850	.2384	41 58.7190	6.955	30.9915	359 58 12.420	57 56.555	n 6.3857632	.07654	.05638
1855	.2422	46 10.5611	7.584	28.6683	0 0 8.315	359 59 51.685	.....	.07797	.05595
1865	.2511	0 54 34.2290	8.804	24.0216	4 0.079	0 3 41.937	6.6867786	.08082	.05509
1875	.2613	1 2 57.8752	9.977	19.3746	7 51.833	7 32.179	6.9877996	.08367	.05423
1880	.2670	7 9.6902	10.547	17.0510	9 47.707	9 27.297	7.0847050	.08509	.05380
1885	.2731	11 21.4998	11.103	14.7274	11 43.578	11 22.411	7.1638814	.08652	.05336
1895	.2863	19 45.1027	12.179	10.0799	15 35.313	15 12.634	7.2888106	.08937	.05250
1905	.3010	28 8.6839	13.249	27 5.4321	19 27.039	19 2.847	7.3857108	.09221	.05164
1920	.3442	1 49 7.5429	15.567	26 53.8113	29 6.311	28 38.339	7.5617769	.09934	.04948
1935	.3966	2 10 6.2647	17.624	42.1889	38 45.528	38 13.774	7.6866900	.10646	.04372
1980	.4581	31 4.8518	19.378	30.5646	48 24.688	47 49.154	7.7835735	.11358	.04517
2005	23 27 54.5289	+2 52 3.3035	+20.830	23 28 18.9387	0 58 3.795	0 57 24.479	7.8627277	+16.12070	+20.04301

By means of these quantities we may readily transfer the position of any star, with reference to the mean equinox of any one date, to the corresponding spherical coördinates referred to the mean equinox of any other date within the limits of the table.

Our data consist of the positions given in the tables on pages 4 and 5, and cited direct from the catalogues already quoted; the mean year of observation being given for the more recent catalogues, in cases where it differs perceptibly from the epoch adopted.

The year of observation for STRUYE's declinations is the same which is given for the same stars in the table of right-ascensions; being 1824, excepting in three instances: it is 1828 for α *Cephei*, and 1832 for the two stars 32 *Camelopardalis* (foll.) and α *Cephei*.

An error of $-15''$ has been assumed in the declination of α *Ursæ Minoris*, FEDORENKO's Lalande, No. 2878 (p. xviii); as has also one of $+5''$ in GROOMBRIDGE's declination of 79 *Draconis*.

Reducing these places to the mean equinox of 1855.0 by means of the data given in the previous tables, and expressing all in time, we are in possession of a series of positions which, after due reduction to the same equinoctial points, will furnish

all needful means for reducing standard positions and values for the proper motion. These proper motions will of course be dependent upon and belong with the values adopted for the constants of precession; but any error arising from an erroneous assumption of the values of these constants will be eliminated (at least so far as relates to terms of the first order), provided that the correlative values of precession and proper motion are legitimately employed together as parts of one system. The places, as thus reduced to the mean equinox of 1855.0, are given in tabular form on pages 6 and 7.

The next problem is to obtain, from direct or indirect comparison of the several catalogues employed with some adopted standard, their constant or systematic differences, in order that the application of the resulting corrections to the places above given may reduce them all to identical equinoctial points.

For this purpose I have taken the *Positiones Mediæ* of ARGELANDER as the standard of comparison, and endeavored to apply such corrections to the places as observed by other astronomers, as would refer these to the identical equinoctial points to which the places of this catalogue are referred, as well as those of the northern and southern zones observed by Professor ARGELANDER at Bonn. These differences are, of

course, merely approximate; deduced as many of them necessarily must be, from combination of various similar and very small differences, not always deduced from fully adequate data.

BRADLEY'S observations are of course taken from BESSEL'S *Fundamenta Astronomiæ*. The right-ascensions are to be corrected⁽¹⁾ by $-0.5 = -0.033$ to reduce to LINDENAU'S determination of the nutation, and thus to the standard zero of the *Tabulæ Regiomontanæ*. The right-ascensions of ARGELANDER depend on BESSEL'S catalogue for 1825.0; and to render them comparable with those of the *Fundamenta*, we have the farther correction of -0.072 to be applied to the latter.⁽²⁾

For the declinations of the *Fundamenta* [we have,⁽³⁾ according to STRUVE,

$$\Delta\delta = -1''.50(1 - \frac{1}{90}\delta) = -1''.50 + 0.017\delta.$$

The observations of LALANDE are as reduced by FEDORENKO in his Catalogue of Mean Positions for 1790 of LALANDE'S circumpolar stars. These places, being already deduced with reference to ARGELANDER'S fundamental positions,⁽⁴⁾ require no further modification.

ARGELANDER has given a full discussion of the relations of PIAZZI'S right-ascensions and declinations to his own, in the Introduction to his wonderfully accurate catalogue of mean places of 560 stars. From this we find⁽⁵⁾ the corrections of the right-ascensions of PIAZZI'S second catalogue,

$$A - P = +0''.93 + 1''.35\sqrt{1.5 + \sec^2\delta},$$

in which the first term reduces to LINDENAU'S nutation*. For

the corrections in declination, a table of values obtained by a graphical method is given⁽⁶⁾ at the close of his § 6.

The constant differences between the positions of GROOMBRIDGE'S catalogue and those of ARGELANDER are carefully investigated by FEDORENKO,⁽⁷⁾ and the formulas deduced:

$$\begin{aligned} \text{Argelander} - \text{Groombridge} &= +2''.31 + 1''.77 \tan \delta \text{ in right-ascension,} \\ &= +0''.649 \text{ in declination.} \end{aligned}$$

Since there can be no doubt that GROOMBRIDGE'S meridian mark was in error⁽⁸⁾ by about $2''\frac{1}{2}$, I have preferred to distinguish between the terms dependent upon this azimuthal error, and those which are strictly referable to differences between the equinoctial points implicitly adopted and those of ARGELANDER. Availing myself therefore of the data as given by FEDORENKO, but submitting these to a new computation for the purpose of furnishing an equation having one term constant, and the other multiplied by $\sin(\delta - q) \sec \delta$, this equation was found to be

$$\text{Argelander} - \text{Groombridge} = +4''.608 + 2''.530 \sin(\delta - 51^\circ 28') \sec \delta.$$

The corrections given by FEDORENKO differ from those indicated by this formula by unimportant amounts until we pass the parallel of 80° , the difference only amounting to $0''.1$ for $\delta = 84^\circ$. Our formula reduces the sum of the squares of the residuals from $3''.685$ to $3''.248$ if we give to each observation an equal weight, and from $58''.65$ to $48''.79$ if weights be assigned the several equations of condition proportional to the number of observations from which they are deduced. The table of comparison will then stand, for the difference in right-ascension $A - G$:

Declination.	Mean δ .	No. Comp.	Argelander — Groombridge.		Form.—Obs.	$r \cos \delta$.
			Observation.	Formula.	r .	
44° to 48°	46° 19'	13	+ 3.38 ± 0.40	+ 4.28	+ 0.90	+ 0.62
48° " 52°	49° 29'	21	+ 4.41 ± 0.10	+ 4.47	+ 0.06	+ 0.01
52° " 56°	53° 27'	16	+ 4.81 ± 0.36	+ 4.76	— 0.05	— 0.03
56° " 59°	57° 31'	23	+ 5.72 ± 0.52	+ 5.10	— 0.62	— 0.33
59° " 62°	60° 55'	18	+ 6.07 ± 0.78	+ 5.46	— 0.61	— 0.30
62° " 65°	63° 29'	12	+ 6.35 ± 0.96	+ 5.79	— 0.56	— 0.25
65° " 69°	67° 1'	20	+ 5.68 ± 0.95	+ 6.34	+ 0.66	+ 0.26
69° " 72°	70° 5'	13	+ 6.39 ± 0.18	+ 6.98	+ 0.59	+ 0.20
72° " 74°	72° 50'	12	+ 7.86 ± 1.42	+ 7.73	— 0.13	— 0.01
74° " 78°	76° 4'	14	+ 8.59 ± 1.43	+ 8.98	+ 0.39	+ 0.09
78° " 80°	79° 3'	8	+ 11.42 ± 2.72	+ 10.78	— 0.64	— 0.12

The amount by which GROOMBRIDGE'S meridian-sign was too far east of north,⁽⁹⁾ would, according to this formula, be

* A formula deduced since the preparation of this report gives, as a still closer reduction,

$$A - P = +0''.0638 + 0''.0801 \sin \delta + 0.0731 \tan \delta.$$

(1) BESSEL, *Astr. Nachr.* IV, p. 402. ARGELANDER, *Pos. Med.* p. vi.

(2) ARGELANDER, *DLX Stellarum Fixarum Pos. Med.* p. iii.

(3) STRUVE, *Stell. Fix. Pos. Med.* p. cxxxx.

(4) FEDORENKO, *Positions Moyennes pour 1790 des Etoiles Circumpolaires de LALANDE, Introd.* p. vi.

$2''.53$; a value differing less than $0''.1$ from that deduced by STRUVE⁽¹⁰⁾.

(5) ARGELANDER, *DLX Stell. Fix. Pos. Med.* pp. viii–ix.

(6) ARGELANDER, *DLX Stell. Fix. Pos. Med.* p. xi.

(7) *Positions Moyennes des Etoiles Circumpolaires*, pp. viii–ix.

(8) AIRY, *Introd. to GROOMBRIDGE'S Cat.* p. x. STRUVE, *Pos. Med.* p. cxxviii.

(9) AIRY, *Introd. to GROOMBRIDGE'S Catalogue*, p. x.

(10) *Pos. Med.* p. cxxviii.

RIGHT-ASCENSIONS FROM THE CATALOGUES.

No.	NAME.	BRADLEY. (1755)	LALANDE. (1746)	PIAZZI. (1800)	GROOMBRIDGE. (1810)	STRUVE. in s	ARGELANDER. (1830)	POND. (1830)	PETERS. (1840)	AIRY. (1840)	AIRY. (1845)	AIRY. (1850)	JOHNSON. (1855)
1	21 Cassiopeæ	h m s	in s	in s	in s	in s	in s	in s	in s	in s	in s	in s	in s
2	Polaris	0 29 56.53	32 6.22	32 42.80	33 19.00	34 11.89	1824	59 31.16		62 10.75	63 31.26	65 1.35	35 31.15
3	4 Cassiopeæ	0 43 42.29	50 18.51	52 25.30	51 37.56	58 0.24	1824	18 42.96			50 19.60	20 9.19	63 35.62
4	50 Cassiopeæ	1 13 24.78	15 53.06	16 31.00	17 16.68			49 5.55	49 51.67		16 22.67		50 19.13
5	7 Cassiopeæ	1 43 30.94	45 50.62	46 38.70	47 27.30	14 42.00	1824	15 10.55					16 22.66
6	48 Cephei	2 9 15.55	12 0.38	12 47.91	13 31.87			59 4.60			38 39.96	39 10.10	60 53.07
7	α Camelopardal.	2 51 20.08	54 20.08	55 30.60	56 40.30			37 12.45	38 11.37				38 41.01
8	Groombr. 966	4	11 45.41	34 16.17	35 14.86	36 37.26	1824	17 3.48					19 2.27
9	22 Camelopard.	5		56 47.30	57 53.06			60 6.16	61 12.29		61 45.41		61 45.49
10	51 Cephei	5	57 37.97	62 42.95	67 58.61			78 15.86		83 25.69	85 58.40		85 59.19
11	Piazzi VII, 67	7	8 51.60	9 56.00	10 58.88			13 6.65	14 9.93				15 13.56
12	3 Ursæ Majoris	7 48 4.64	51 41.10		53 43.72			55 47.91		56 48.09			57 18.41
13	62 Ursæ Majoris	8 48 27.76	51 40.15	52 35.18	53 28.97	54 46.30	1824	12 7.81	13 41.90		56 40.31		56 40.36
14	1 Draconis	9	5 40.70	7 22.20	8 57.35			19 18.12		13 42.19	11 29.26	15 15.45	11 28.94
15	24 Ursæ Majoris	9 12 19.83	15 35.88	16 32.13	17 26.94					20 12.86			20 40.15
16	32 Ursæ Majoris	9 59 51.99	2 31.18	3 20.20	4 4.59								7 4.68
17	9 Draconis	10 13 28.25	16 41.16	17 38.40	18 33.02			20 21.20	21 17.76				22 11.89
18	4 Draconis	11 16 32.69	18 44.19	19 21.80	19 58.55	20 50.61	1824	21 12.91	21 49.58		22 8.05	22 26.50	22 8.02
19	4 Draconis	12 0 21.63	2 8.12	2 38.50	3 6.87			4 7.39	4 36.75	4 37.00			4 51.98
20	α Draconis	12 22 52.59	24 25.06	24 51.27	25 17.84	25 51.93	1824	26 10.87	26 36.79	26 36.97			27 3.37
21	32 Camelop. (foll.)	12 47 48.73	47 53.85	47 52.00	47 53.71	48 0.52	1832	48 0.56		48 4.08			48 5.76
22	α Draconis	13 57 46.33	58 42.42	58 58.41	59 14.86	59 37.60	1824	59 47.36	60 3.60	60 3.69			60 11.77
23	5 Ursæ Minoris	14 28 23.03	28 11.15	28 8.30	28 4.45	28 1.08	1824	27 59.29	27 59.33		27 55.66	27 51.45	27 55.72
24	β Ursæ Minoris	14 51 42.59	51 30.13	51 26.67	51 22.80	51 19.35	1824	51 17.41	51 14.47	51 14.85	51 13.37	51 12.01	51 13.33
25	γ Ursæ Minoris	15	21 11.76	21 8.72	21 6.78	21 4.97	1824	21 3.75	21 1.97	21 1.11			21 1.29
26	5 Ursæ Minoris	15	51 55.70	51 30.47	51 4.97	50 33.02	1824	50 18.85	49 51.93	49 55.19	49 43.20	49 31.80	49 43.41
27	Groombr. 2320	16	5 49.19		5 51.21			5 53.51			5 55.28		5 55.48
28	15 Draconis	16	28 27.47	28 26.00	28 23.95			28 21.23	28 19.41		28 18.84		28 18.72
29	ε Ursæ Minoris	17 11 57.59	8 4.92	6 55.67	5 51.28	4 20.28	1824	3 40.91	2 36.28	2 36.33	2 4.19	1 31.60	2 3.50
30	ω Draconis	17 38 24.97	38 11.91	38 8.00	38 4.11			37 57.23	37 57.47	37 53.64	37 51.87	37 50.20	37 51.87
31	ψ Ursæ Minoris (pr.)	17 46 21.45	45 42.11	45 31.40	45 20.32	45 5.16	1824	45 3.03			41 37.06	41 42.35	
32	8 Ursæ Minoris	18 50 36.29	39 47.26	36 35.07	33 28.63	29 2.30	1824	27 8.31		23 56.23	22 19.96	20 43.59	22 20.09
33	50 Draconis	18 54 8.74	53 3.56	52 43.47	52 25.66			51 48.94					51 20.50
34	δ Draconis	19 12 25.63	12 27.96	12 27.87	12 28.45	12 29.35	1824	12 29.68	12 29.98	12 29.96	12 30.31	12 30.08	12 30.23
35	τ Draconis	19 20 6.10	19 30.01	19 18.50	19 7.55			18 46.53	18 35.27				18 29.83
36	ε Ursæ Minoris	19 48 53.07	48 48.41	48 46.20	48 45.21	18 43.33	1824	48 42.51		48 40.47			48 40.09
37	λ Ursæ Minoris	20 77 41.51	58 2.38	51 22.80	44 41.23	41 8.50	1815	14 27.49		21 39.24	17 23.99	13 1.15	17 22.53
38	κ Cephei	20 16 40.11	15 39.75	15 18.60	15 3.00	14 31.35	1828	30 40.91		14 8.93			13 59.83
39	Groombr. 3241	20	30 47.49	30 45.17	30 41.29			30 40.91					30 37.60
40	T.Y.C. 1879	20 57 50.08	56 34.44		55 48.72			55 1.07	55 1.21	54 37.24			54 25.33
41	β Cephei	21 25 21.23	25 53.31	26 0.95	26 9.48	26 21.24	1824	26 26.11	26 34.24	26 34.21	26 38.31	26 42.33	26 38.31
42	11 Cephei	21 38 11.53	38 46.71	38 55.40	39 5.17			39 21.14		39 38.32			39 37.71
43	79 Draconis	21 49 47.21	50 14.24	50 21.40	50 30.24								51 0.30
44	226 Cephei	22	28 31.38		28 53.22			29 15.76	29 26.19				29 31.72
45	γ Cephei	22 11 1.53	42 14.85	42 35.30	42 56.50	43 26.28	1824	43 38.81	44 0.02	44 0.15			44 10.51
46	δ Cephei	23 8 40.14	10 4.17	10 27.87	10 52.27	11 45.68	1832			12 5.13			12 17.09
47	γ Cephei	23 29 30.25	30 52.31	31 14.55	31 38.70	32 12.21	1824	32 26.49	32 50.11	32 50.14	33 2.07	33 14.06	33 2.03
48	Groombr. 4163	23	41 47.41		45 42.58			46 39.60					47 21.14

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NO. 2.

ON THE MEAN PLACES FOR 1855.0 OF FORTY-EIGHT CIRCUMPOLAR STARS.

REPORT TO PROFESSOR A. D. BACHE, SUPERINTENDENT U. S. COAST SURVEY.

By B. A. GOULD JR.

[Communicated by Authority of the Hon. Secretary of the Treasury.]

Continued from the last number.

The equinoctial points of the Radcliffe Catalogue are those of the Nautical Almanac for 1840; so that for the right-ascensions, we have at once

$$\text{Argelander} - \text{Greenw. Catal. 1840.0} = +0^{\circ}094,$$

$$\text{Greenw. Catal. 1840.0} - \text{Johnson} = -0.089;$$

whence

$$\text{Argelander} - \text{Johnson} = +0^{\circ}.005,$$

a quantity utterly inappreciable.

For JOHNSON'S declinations,⁽¹⁾ I have compared his determinations of the stars of our list with those given by ARGELANDER, STRUVE, GROOMBRIDGE and POND, and find

$$\text{from 13 stars, Argelander} - \text{Johnson} = +0.580 \pm 0.087$$

$$\text{" 23 " Struve} - \text{Johnson} = +0.320 \pm 0.085$$

$$\text{" 47 " Groombridge} - \text{Johnson} = -0.074 \pm 0.094$$

$$\text{" 42 " Pond} - \text{Johnson} = +0.352 \pm 0.087$$

The places of POND'S catalogue were corrected by ARGELANDER'S table⁽²⁾ before comparison; so that each of these comparisons, excepting that with GROOMBRIDGE, gives a determination of the correction desired. One will also be obtained from this by the employment of the equation⁽³⁾ already adopted,

$$\text{Argelander} - \text{Groombridge} = +0^{\circ}.649,$$

which gives us

$$\text{Argelander} - \text{Johnson} = +0^{\circ}.575.$$

We will adopt the mean by weights of these four determinations,

$$\text{Argelander} - \text{Johnson} = +0^{\circ}.45;$$

(1) See Radcliffe Observations 1848, p. x; FÖRSTER, *Astr. Nachrichten*, XLIII, p. 279.

(2) ARGELANDER, *Pos. Med.* p. v.

(3) FEDORENKO, *Positions moyennes*, p. ix.

which, from the fair accordance of the several values, seems very trustworthy.

Our adopted values of the corrections to be applied to the observations of the several authorities, in order to refer them to the standard of ARGELANDER, are then as follows:

IN RIGHT-ASCENSION.

Bradley (<i>Fundam. Astron.</i>),	$-0^{\circ}.033$
Lalande (<i>Fedorenko</i>),	0.0
Piazzi (<i>Catal. 1814</i>),	$+0.062 + 0^{\circ}.091 \cdot 1.5 + \sec^2 \delta$
Groombridge,	$+0.307 + 0.169 \sin(\delta - 51^{\circ} 28') \sec \delta$
Struve (<i>Catal. Gen.</i>),	-0.069
Pond,	-0.075
Peters (<i>Exp. Chron. 1844</i>),	0.0
Airy (<i>Catal. I</i>),	$+0.094$
" (<i>Catal. II</i>),	$+0.027$
" (<i>Catal. III</i>),	$+0.051$
Johnson (<i>Radcl. Catal.</i>),	0.0

IN DECLINATION.

Bradley (<i>Fundam. Astron.</i>),	$-1^{\circ}.50 + 0^{\circ}.017 \delta^2$
Lalande (<i>Fedorenko</i>),	0.0
Piazzi (<i>Catal. 1814</i>),	Table, Argelander <i>Pos. Med.</i> p. xi.
Groombridge,	$+0^{\circ}.65$
Struve (<i>Catal. Gen.</i>),	0.0
Pond,	Table, Argelander <i>Pos. Med.</i> p. v.
Airy (<i>Catal. I, II, III</i>),	-0.24
Johnson (<i>Radcl. Catal.</i>),	$+0.45$

The several catalogue-places thus corrected, when combined according to the method of least squares, furnish equations whose solution gives the values to be adopted for the places and the proper motions. For forming these equations, it seemed best, after full consideration, to attribute to each catalogue-place an equal weight.

For the sake of the proper-motions, the observations of a century ago, made with such appliances as stood at BRADLEY's command, the quadrant-determinations of LALANDE made in his unsteady tower, and right-ascensions which, despite the skill and zeal even of PIAZZI and GROOMBRIDGE, were referred to erroneous meridian-marks, are thus combined with the exquisitely delicate measures of STRIVE and ARGELANDER and the standard catalogues of AIRY and JOHNSON. Positions deduced from such a combination cannot claim that sharp precision which observations of recent years, with the refined implements of the present day and the delicate precautions of the new school, may boast. Their probable errors will be reckoned in as many tenths, as those of Pulkowa and Åbo are in hundredths, of seconds. Still we have thus determined the proper-motions with a greater precision than would otherwise be possible; and certainly when the computation of a mean or an apparent place is for an epoch several years removed from the date of the observations upon which the standard catalogues are based, a large part of the accuracy of the computed position depends upon that of the proper-motion. But a simple course lies open to us, which, although laborious, will afford more trustworthy results than can be hoped for in any other way; especially for the right-ascensions in these high declinations. Adopting the corrections just deduced, and solving the resultant equations, we obtain at once the values of the proper-motions which are to be adopted, and positions which we may discard because depending upon the combination of observations of different orders of excellence. In the course of the computation, the faulty observations are naturally brought to notice, and may be rejected if Peirce's Criterion permit,—thus greatly improving many of the proper-motions. Then the adoption of these proper-motions enables us to deduce yet better values for the corrections to the standard equinox; and by the employment of these improved corrections jointly with the new proper-motions, we may obtain positions of high value from the modern observations alone.

The series of positions from which the proper-motions are to be derived, is obtained by applying, to the places of the last tables, those approximate corrections which have just been deduced for reference to the equinoctial points of ARGELANDER. (See tables on pages 11 and 12.)

In the progress of the solutions, it was seen that several of the positions were beyond question incorrect; others would be excluded by Peirce's Criterion, and a few were evidently affected by some large and easily recognizable error. The omissions and modifications made are here detailed in full.

RIGHT-ASCENSIONS.

The following catalogue-places have been rejected :

Bradley	.. No. 1.
Lalande	.. Nos. 21, 32 and 40.
Piazzini	.. Nos. 19, 23, 29, and 38.
Groombridge	.. Nos. 26 and 40.
Pond	.. Nos. 8, 12, 14 and 31.

No. 14. Lalande's observation, Fedorenko 1476, is assumed to be in error by 10", so that the mean catal.-place should read $9^h 5^m 45^s.70$.

No. 24. The first two observations of Lalande, Fedorenko Nos. 2549 and 2550 were excluded, and the last three retained.

No. 31. The star ψ' *Draconis* is double. The position of the companion, as noted by Lalande, agrees with that of the brighter component according to other observers. Careful examination leaves no doubt on my mind that the error is simply a transposition of the magnitudes by Lalande. The two stars are Fedorenko's Nos. 2907 and 2908.

In Pond and the Greenwich Catalogue for 1850.0, the two components of ψ' *Draconis* are called ψ^1 and ψ^2 . In Bradley, Lalande, Groombridge, and Argelander, the first is also called ψ^1 , but the character ψ^2 given to a star of the sixth magnitude, situated

$$a = 17^h 57^m.8, \quad \delta = +72^\circ 1'.1.$$

DECLINATIONS.

The following catalogue-places have been rejected :

Bradley	.. Nos. 17, 19, 21, 22, 23 and 46.
Lalande	.. Nos. 6, 11, 15, 28, 32, 33, 36 and 41.
Piazzini	.. Nos. 3, 5, 24, 30, 37 and 41.
Groombridge	.. Nos. 4, 6, 17, 35, 46 and 48.
Pond	.. No. 33.

No. 29. Assumed an error of $-15''$ for the second observation of No. 2878, Fedorenko's Lalande. This will give as the mean $82^\circ 21' 18''.4$.

No. 38. For Lalande's declination, the mean of the places in the General and Supplementary Catalogues of Fedorenko was employed.

No. 43. Groombridge's place assumed to be $5''$ in error, so that the declination in the catalogue should read $72^\circ 48' 17''.9$.

No. 48. The declinations of this star, as given by the different authorities, differed so much among themselves, that I did not feel justified in placing any reliance upon the proper-motion obtained by the retention of all, or by the exclusion of any one. In this embarrassment I appealed to my friend Professor YARNALL of Washington for a new observation, which he kindly made and furnished. The employment of this determination, in conjunction with all the rest excepting Groombridge, led to the values of $\Delta\delta$ and μ' given in the table; and by this value of the proper-motion, the places of Pond and Johnson given in the Synoptical Table have been brought up to the epoch 1855.

The results of the computation are given on page 13 in tabular form. As will be seen, a small change was thereby deduced for the constant correction to BRADLEY's right-ascensions; and since these exert a more important influence than any others upon the determination of the proper-motions, such slight additional labor as was necessary for introducing the consequent modifications has been bestowed, so that the values here given for the proper-motion, μ , result from the correction of the right-ascensions of the *Fundamenta* by the quantity $-0''.106$, or $-0''.073$ in addition to the reduction for difference of nutation. The right-ascensions of the four polar stars α , δ , and λ *Ursæ Minoris* and 51 *Cephei* depend upon a more minute investigation, yet to be described; but for the sake of symmetry, the results are incorporated in our table with the rest.

MEAN RIGHT-ASCENSIONS FOR 1855.0, CORRECTED BY THE FOREGOING EQUATIONS.

No.	NAME.	BRADLEY.			LALANDE	PIAZZI	GROOME.			STRUVE.	ARGEL.	POND.	PETERS.	AIRY.		JOHNSON.	
		h	m	s			s	s	year					s	year	s	year
1	21 Cassiopeæ	0	36	10.23	10.85	10.62	9.59	9.30	1825							9.21	1844
2	Polaris	1	6	22.38	24.74	27.83	28.72	27.41	1821			27.59		29.24	1845	30.23	1843
3	4 Cassiopeæ	1	20	28.21	29.86	28.93	29.39					30.03		30.74	1850		
4	50 Cassiopeæ	1	51	9.85	9.06	9.02	9.06				8.77	8.85	8.84	9.12	1845	8.62	1844
5	1 Cassiopeæ	2	17	11.60	11.28	11.66	11.11	10.89	1823			10.69		10.89	1845	10.85	1843
6	48 Cephei	3	2		5.25	5.64	4.54					5.17				5.59	1845
7	α Camelopard.	4	39			40.12	40.23	39.88	1824			39.75	39.85	39.60	1850	40.02	1844
8	Groombr. 966	5	20		21.39		21.42					22.29		21.83	1853	21.89	1847
9	22 Camelopard.	6	2			51.85	51.50					51.63	51.62	51.66	1846	51.71	1843
10	51 Cephei	6	31		13.88	9.12	13.67					6.98		6.49	1846	6.99	1846
11	Piazz VII, 67	7	15		41.38	45.14	44.74					44.94	44.89	45.24	1849	45.13	1844
12	3 Ursæ Majoris	7	58	18.88	19.06		19.16					20.31		19.58	1838	19.34	1844
13	62 Ursæ Majoris	8	57	34.81	34.22	34.72	33.92	34.38	1823					34.44	1845	34.46	1846
14	1 Draconis	9	16		1.53	5.90	4.29					2.36	2.04	2.29	1815	2.16	1844
15	24 Ursæ Majoris	9	21	35.88	35.34	36.16	35.48					35.43		35.25	1838	34.97	1842
16	32 Ursæ Majoris	10	7	28.56	27.96	28.51	27.64						27.15	27.13	1848	27.24	1842
17	9 Draconis	10	22	38.93	38.70	38.04	37.75					39.01	38.48	38.77	1849	38.85	1845
18	2 Draconis	11	22	45.57	45.23	45.78	45.36	44.88	1824			44.95	44.77	44.90	1849	44.78	1843
19	4 Draconis	12	5	20.33	21.00	21.60	20.27					20.70	20.69	21.03	1838	21.24	1845
20	z Draconis	12	27	17.59	16.66	16.66	16.85	16.40	1824			16.50	16.18	16.47	1841	16.29	1844
21	32 Camelop. (foll.)	12	48	8.70	9.78	7.30	7.23	7.37	1831			7.94		7.34	1845	7.12	1849
22	α Draconis	14	0	28.92	28.18	28.24	28.50	27.99	1824	28.06	28.08	28.02	28.20	1836	28.05	1846	
23	5 Ursæ Minoris	14	27	52.95	53.09	53.83	53.13	53.07	1824	52.98	52.94		53.28	1850	53.29	1844	
24	β Ursæ Minoris	14	51	11.29	11.04	11.23	10.62	10.73	1824	10.60	10.59	10.46	10.82	1844	10.68	1841	
25	γ Ursæ Minoris	15	20		59.81	59.20	59.36	59.61	1824	59.54	59.38	59.50	59.51	1846	59.66	1842	
26	δ Ursæ Minoris	15	49		19.60	19.49	18.52	19.60	1824	19.58	19.77	19.69	20.00	1845	20.00	1841	
27	Groombr. 2320	16	5		57.13		57.33					56.72		56.65	1846	56.82	1846
28	15 Draconis	16	28		16.85	17.47	17.45					17.28	17.12	17.35	1846	17.20	1843
29	ε Ursæ Minoris	17	0	57.98	59.37	57.11	58.91	58.78	1824			58.60	59.17	59.37	1846	58.83	1841
30	ω Draconis	17	37	47.91	48.03	48.14	48.10			48.10	48.26	48.17	48.37	1849	48.23	1844	
31	ψ Draconis (pr.)	17	44	31.89	31.12	31.72	31.72	31.29	1824	31.49	35.71		31.67	1850	31.46	1844	
32	δ Ursæ Minoris	18	19	3.73	5.30	3.24	6.77	5.44	1824			6.43		6.81	1845	6.86	1844
33	50 Draconis	18	51	3.02	2.23	1.08	1.98					1.92				1.68	1844
34	δ Draconis	19	12	28.55	29.62	29.54	29.93	29.95	1824	30.14	30.13	30.28	30.37	1840	30.42	1844	
35	τ Draconis	19	18	22.14	21.62	20.87	20.47					19.87	19.28	19.19	1853	19.15	1844
36	ε Draconis	19	48	37.33	37.71	37.38	38.08	37.93	1824			38.10		38.74	1845	38.33	1844
37	λ Ursæ Minoris	20	8	35.95	37.45	27.94	36.62	32.39	1815	31.89				32.27	1846	31.05	1846
38	z Cephei	20	13	41.20	41.67	38.74	41.17	41.41	1828			41.19		41.17	1836	41.22	1846
39	Groombr. 3241	20	30		36.26	36.16	36.77					36.17				35.69	1851
40	T.Y.C. 1879	20	54	1.60	2.67		3.10			1.22	1.31			1.20	1840	1.17	1846
41	β Cephei	21	26	46.27	46.31	46.03	46.46	46.26	1824	46.26	46.24	46.34	46.40	1845	46.37	1841	
42	11 Cephei	21	39	41.69	41.97	41.96	45.83					46.31		47.23	1845	46.59	1848
43	79 Draconis	21	51	3.12	3.10	3.01	4.38							4.04	1854	3.61	1851
44	226 Cephei	22	29		42.92		43.18					43.04	42.58			42.64	1846
45	ι Cephei	22	44	33.00	32.56	32.19	32.34	32.00	1824	31.91	31.89	31.88	32.10	1839	31.76	1844	
46	ο Cephei	23	12	39.79	40.69	40.48	41.05	41.08	1830				41.33	1844	41.23	1844	
47	γ Cephei	23	33	27.86	27.58	26.57	27.11	26.54	1824	26.38	26.47	26.20	26.21	1844	26.11	1842	
48	Groombr. 4163	23	47		49.65		49.63					50.02				49.40	1846

MEAN DECLINATIONS REFERRED TO 1855.0, AND CORRECTED BY THE FOREGOING EQUATIONS.

No.	NAME.	BRADLEY.			LALANDE.	PIAZZI.	GROOMBR.	STRUVE.		ARGEL.	POND.	AIRY.		JOHNSON.	
		°	'	"	"	"	"	"	year	"	"	"	year	"	year
1	21 Cassiopeæ	71	11	44.4	43.4	41.5	41.0	11.1	1825					39.1	1843
2	Polaris	88	32	10.7	10.6	10.9	11.4	11.0	1824		10.8	11.1	1845	11.4	1843
3	A Cassiopeæ	69	31	6.3	3.7	7.5	1.5				59.7	59.2	1849	59.0	1849
4	50 Cassiopeæ	71	42	57.8	0.0	58.8	56.9			58.9	57.4	59.0	1848	58.3	1842
5	† Cassiopeæ	66	41	49.8	50.1	47.9	49.2	18.2	1823		48.7	48.3	1844	48.6	1846
6	48 Cephei	77	11	46.4	46.1	43.5	44.7				41.5			40.7	1845
7	α Camelopardal.	66	5			20.6	19.9	20.7	1824		21.4	20.4	1844	20.8	1847
8	Groombr. 966	74	56		14.8		15.6				14.7	14.9	1848	15.0	1845
9	22 Camelopard.	69	21			50.9	49.5				17.1	46.0	1841	45.9	1847
10	51 Cephei	87	15		5.0	13.0	11.1				6.6	8.6	1844	9.8	1846
11	Piazzi VII, 67	68	45		25.0	19.8	17.3				16.8	15.9	1848	15.5	1846
12	3 Ursæ Majoris	68	53		40.1		39.4				40.1	39.4	1841	39.2	1845
13	σ ² Ursæ Majoris	67	43	15.9	9.8	8.5	11.1	7.7	1823	7.3		6.8	1841	6.8	1844
14	1 Draconis	81	57		37.5	39.0	38.7				37.8	38.0	1840	38.9	1850
15	24 Ursæ Majoris	70	27	43.6	41.1	46.1	47.0				47.4	47.5	1841	48.8	1850
16	32 Ursæ Majoris	65	49	48.4	47.5	47.5	47.3					45.4	1846	45.3	1846
17	9 Draconis	76	27	26.9	28.4	28.7	29.6				27.6	26.8	1848	26.9	1850
18	λ Draconis	70	7	56.2	55.3	51.9	53.9	51.9	1824		50.9	51.2	1843	51.2	1848
19	4 Draconis	78	25	16.5	19.0	19.9	19.6				18.7	19.2	1846	18.9	1850
20	z Draconis	70	35	18.5	17.2	17.2	17.2	17.0	1824		16.6	16.1	1841	16.2	1845
21	32 Camelop. (foll.)	84	12	1.6	5.5	4.9	4.4	3.8	1831		4.2	4.5	1842	4.1	1846
22	α Draconis	65	4	11.1	13.5	12.2	13.3	12.0	1824	11.8	10.9	11.8	1842	11.7	1843
23	5 Ursæ Minoris	76	20	27.3	27.0	25.9	26.4	26.0	1824		25.7	25.6	1843	25.9	1845
24	β Ursæ Minoris	74	44	55.8	53.2	54.7	53.1	53.0	1824	52.9	53.2	52.9	1843	52.5	1850
25	γ ² Ursæ Minoris	72	20	51.4	57.4	59.3	58.6	59.5	1824	59.6	58.8	59.2	1837	59.6	1846
26	γ ¹ Ursæ Minoris	78	14	17.7	19.5	17.4	18.4	18.1	1824	18.3	17.9	17.7	1844	17.8	1844
27	Groombr. 2320	68	11		28.2		29.2				30.5	31.9	1846	32.2	1846
28	15 Draconis	69	4	50.5	55.9	54.0	53.1				53.6	53.6	1838	54.0	1846
29	ε Ursæ Minoris	82	16	6.6	5.8	8.6	6.8	6.7	1824		6.6	6.5	1844	7.1	1843
30	ω Draconis	68	48	57.8	8.7	13.9	12.7			19.6	19.9	25.7	1846	23.6	1847
31	ψ ¹ Draconis (pr.)	72	13	33.3	23.4	23.3	19.6	15.7	1824	14.1	13.5	8.8	1849	9.2	1848
32	δ Ursæ Minoris	86	35	56.6	59.4	56.8	56.6	57.4	1824		56.8	58.5	1845	58.0	1844
33	50 Draconis	75	15	31.2	37.9	36.0	34.3				29.1			37.0	1851
34	δ Draconis	67	24	16.0	19.6	19.5	19.4	20.8	1824	21.7	21.4	22.3	1841	22.9	1852
35	τ Draconis	73	4	55.3	58.9	0.4	59.5				3.0	4.8	1853	5.0	1851
36	ε Draconis	69	53	51.8	50.4	52.8	53.4	53.8	1824		51.6	54.3	1836	53.7	1850
37	λ Ursæ Minoris	88	52	30.6	31.3	29.4	31.5			31.8	31.5	32.0	1846	32.2	1843
38	z Cephei	77	16	20.9	21.6	19.4	20.0	20.5	1828		20.8	20.8	1837	21.0	1845
39	Groombr. 3241	72	2	26.9	26.7	23.9	24.2				25.6			24.9	1844
40	T.Y.C. 1879	80	0		24.3		22.3			22.1	22.0	21.7	1840	21.4	1847
41	β Cephei	69	55	32.5	33.8	28.0	30.3	29.5	1824	29.4	29.6	29.1	1844	29.0	1848
42	11 Cephei	70	38	32.0	33.4	33.1	35.2				36.7	38.3	1839	37.9	1850
43	79 Draconis	73	1	0.8	1.2	0.3	1.1					0.3	1853	59.8	1843
44	226 Cephei	75	28		45.8		45.7				46.6			44.8	1846
45	† Cephei	65	26	32.2	28.6	25.9	25.5	22.8	1824	21.9	22.2	20.8	1837	20.1	1844
46	o Cephei	67	19	4.7	7.9	7.4	5.9	6.5	1831			6.7	1840	6.8	1852
47	γ Cephei	76	49	8.3	14.5	14.6	16.9	19.2	1824	20.3	20.4	21.7	1843	21.4	1848
48	Groombr. 4163	73	36		14.8		12.2				13.1			12.1	1848

SOLUTION OF EQUATIONS FOR PROPER MOTION.

No.	NAME.	Assumed Mean Place 1855.0.		$\Delta\alpha$	μ	$\Delta\delta$	μ'
		α	δ				
		$^{\text{h}}$ $^{\text{m}}$ $^{\text{s}}$	$^{\circ}$ $'$ $''$	$^{\text{s}}$	$^{\text{s}}$	$''$	$''$
1	21 Cassiopeæ	0 36 9.1	71 11 37	-0.528 ± 0.269	-0.0326 ± 0.0059	$+1.72 \pm 0.36$	-0.059 ± 0.006
2	Polaris	1 6 30.33	88 32 11.4	$+0.238 \pm .499$	$+0.0771 \pm .0097$	-0.16 ± 0.11	$+0.006 \pm .002$
3	A Cassiopeæ	1 20 30.7	69 30 58	$+0.022 \pm .239$	$+0.0246 \pm .0011$	$+0.33 \pm 0.19$	$-0.079 \pm .004$
4	50 Cassiopeæ	1 51 8.6	71 42 49	$+0.053 \pm .234$	$-0.0092 \pm .0015$	-0.39 ± 0.39	$0.000 \pm .008$
5	i Cassiopeæ	2 17 10.7	66 44 49	$+0.006 \pm .099$	$-0.0094 \pm .0019$	-0.79 ± 0.19	$-0.019 \pm .001$
6	48 Cephei	3 2 5.8	77 11 42	$-0.138 \pm .335$	$+0.0032 \pm .0075$	-2.01 ± 0.06	$-0.064 \pm .001$
7	α Camelopard.	4 39 39.8	66 5 21	$-0.119 \pm .073$	$-0.0088 \pm .0023$	-0.12 ± 0.28	$+0.009 \pm .008$
8	Groombr. 966	5 20 22.0	74 56 15	$-0.116 \pm .049$	$+0.0084 \pm .0042$	-0.07 ± 0.21	$-0.002 \pm .005$
9	22 Camelopard.	6 2 51.7	69 21 45	-0.079 ± 0.066	$-0.0013 \pm .0024$	-0.27 ± 0.15	$-0.109 \pm .004$
10	51 Cephei	6 31 5.91	87 15 8.1	-0.452 ± 1.121	$-0.1172 \pm .0274$	$+1.00 \pm 1.73$	$+0.002 \pm .042$
11	Piazzi VII, 67	7 15 45.2	68 15 15	-0.016 ± 0.108	$+0.0084 \pm .0028$	$+0.01 \pm 0.41$	$-0.073 \pm .012$
12	3 Ursæ Majoris	7 58 19.4	68 53 40	$+0.143 \pm .064$	$+0.0074 \pm .0011$	-0.70 ± 0.22	$-0.011 \pm .006$
13	σ^2 Ursæ Majoris	8 57 34.4	67 43 6	$-0.098 \pm .137$	$-0.0024 \pm .0025$	-0.88 ± 0.59	$-0.095 \pm .011$
14	1 Draconis	9 16 1.6	81 57 38	$-0.401 \pm .226$	$-0.0786 \pm .0068$	$+0.48 \pm 0.36$	$+0.005 \pm .009$
15	24 Ursæ Majoris	9 21 35.0	70 27 47	$+0.120 \pm .156$	$-0.0081 \pm .0029$	$+1.76 \pm 0.18$	$+0.050 \pm .003$
16	32 Ursæ Majoris	10 7 27.0	65 49 46	$+0.041 \pm .124$	$-0.0161 \pm .0023$	-0.74 ± 0.18	$-0.035 \pm .003$
17	9 Draconis	10 22 38.8	76 27 29	$-0.190 \pm .185$	$+0.0044 \pm .0037$	-2.26 ± 0.13	$-0.030 \pm .003$
18	2 Draconis	11 22 44.7	70 7 50	$+0.059 \pm .093$	$-0.0093 \pm .0019$	$+0.29 \pm 0.42$	$-0.059 \pm .008$
19	4 Draconis	12 5 21.2	78 25 20	$-0.197 \pm .138$	$+0.0067 \pm .0027$	-1.07 ± 0.22	$-0.008 \pm .003$
20	α Draconis	12 27 16.2	70 35 16	$-0.085 \pm .068$	$-0.0121 \pm .0014$	-0.05 ± 0.09	$-0.024 \pm .002$
21	32 Camelop. (foll.)	12 48 7.1	84 12 4	$-0.008 \pm .158$	$-0.0123 \pm .0033$	-0.22 ± 0.19	$-0.021 \pm .005$
22	α Draconis	14 0 27.9	65 4 10	$+0.002 \pm .059$	$-0.0080 \pm .0013$	$+1.02 \pm 0.31$	$-0.034 \pm .008$
23	5 Ursæ Minoris	14 27 53.3	76 20 26	$-0.101 \pm .053$	$+0.0034 \pm .0014$	-0.70 ± 0.15	$-0.020 \pm .003$
24	β Ursæ Minoris	14 51 10.5	74 44 53	$-0.005 \pm .068$	$-0.0078 \pm .0014$	-0.79 ± 0.21	$-0.029 \pm .004$
25	γ^2 Ursæ Minoris	15 20 59.6	72 21 0	$-0.085 \pm .086$	$+0.0004 \pm .0023$	-0.06 ± 0.29	$+0.028 \pm .007$
26	γ Ursæ Minoris	15 49 20.4	78 14 18	$-0.184 \pm .066$	$+0.0067 \pm .0019$	-0.05 ± 0.26	$-0.003 \pm .005$
27	Groombr. 2320	16 5 56.5	68 11 33	$+0.136 \pm .107$	$-0.0095 \pm .0029$	-0.46 ± 0.15	$+0.070 \pm .004$
28	15 Draconis	16 28 17.3	69 4 53	$-0.011 \pm .108$	$+0.0015 \pm .0028$	$+1.56 \pm 0.36$	$+0.034 \pm .007$
29	ϵ Ursæ Minoris	17 0 58.8	82 16 7	$+0.414 \pm .161$	$-0.0092 \pm .0034$	-0.12 ± 0.37	$+0.001 \pm .007$
30	ω Draconis	17 37 48.2	68 19 26	$+0.103 \pm .023$	$+0.0044 \pm .0005$	$+0.97 \pm 0.10$	$+0.292 \pm .008$
31	ψ' Draconis (pr.)	17 44 31.4	72 13 8	$+0.070 \pm .104$	$-0.0016 \pm .0020$	-0.52 ± 0.28	$-0.264 \pm .006$
32	δ Ursæ Minoris	18 19 7.09	86 35 58.7	$+0.435 \pm .253$	$+0.0324 \pm .0050$	-0.77 ± 0.24	$+0.018 \pm .005$
33	50 Draconis	18 51 1.2	75 15 33	$+0.143 \pm .292$	$-0.0125 \pm .0050$	$+4.60 \pm 0.78$	$+0.058 \pm .013$
34	δ Draconis	19 12 30.6	67 21 23	$+0.053 \pm .047$	$+0.0199 \pm .0010$	$+1.16 \pm 0.18$	$+0.068 \pm .004$
35	τ Draconis	19 18 18.9	73 5 3	$+0.070 \pm .097$	$-0.0337 \pm .0019$	$+2.33 \pm 0.13$	$+0.098 \pm .002$
36	ϵ Draconis	19 48 38.6	69 53 53	$-0.056 \pm .104$	$+0.0142 \pm .0020$	$+0.75 \pm 0.33$	$-0.004 \pm .007$
37	2 Ursæ Minoris	20 8 30.89	88 52 32.3	$+0.486 \pm .799$	$-0.0612 \pm .0155$	-0.13 ± 0.07	$+0.015 \pm .001$
38	α Cephei	20 13 41.2	77 16 22	$+0.017 \pm .089$	$-0.0007 \pm .0017$	-1.40 ± 0.31	$0.000 \pm .006$
39	Groombr. 3241	20 30 36.0	72 2 25	$-0.166 \pm .213$	$-0.0096 \pm .0048$	-0.73 ± 0.65	$-0.022 \pm .011$
40	T.Y.C. 1879	20 54 1.1	80 0 22	$+0.048 \pm .013$	$-0.0039 \pm .0003$	-1.21 ± 0.20	$-0.049 \pm .006$
41	β Cephei	21 26 46.3	69 55 28	$+0.052 \pm .043$	$+0.0018 \pm .0009$	$+0.57 \pm 0.07$	$-0.038 \pm .001$
42	II Cephei	21 39 47.4	70 38 39	$-0.448 \pm .175$	$+0.0273 \pm .0029$	-0.55 ± 0.38	$+0.072 \pm .007$
43	79 Draconis	21 51 4.0	73 0 56	$-0.053 \pm .230$	$+0.0092 \pm .0041$	$+4.21 \pm 0.30$	$-0.009 \pm .005$
44	226 Cephei	22 29 42.6	75 28 49	$+0.041 \pm .127$	$-0.0071 \pm .0033$	-3.63 ± 0.56	$-0.010 \pm .014$
45	i Cephei	22 44 31.6	65 26 19	$+0.071 \pm .046$	$-0.0124 \pm .0010$	-0.43 ± 0.20	$-0.141 \pm .004$
46	σ Cephei	23 12 41.4	67 19 8	$+0.130 \pm .086$	$+0.0165 \pm .0016$	-1.56 ± 0.16	$-0.019 \pm .004$
47	γ Cephei	23 33 25.9	76 49 22	$+0.043 \pm .085$	$-0.0195 \pm .0018$	$+1.50 \pm 0.26$	$+0.148 \pm .005$
48	Groombr. 4163	23 47 50.0	73 36 16	-0.385 ± 0.198	-0.0015 ± 0.0047	-3.27 ± 1.15	-0.030 ± 0.010

A comparison of the residuals in right-ascension outstanding after the application of these proper-motions to the observations above given, except for the four polar stars, leads to the following results.

Denoting the constant corrections yet remaining for the scales of Airy, Argelander, Bradley, Groombridge, Johnson, Lalande, Peters, Piazz, Pond and Struve, by the letters Y, A, Br, Gr, J, Ll, Pt, Pz, Pd, S, respectively :

1)	A—S	=	— 0.001 ± 0.022	from 10 observations
2)	A—Pt	=	— 0.018 ± 0.015	“ 10 “
3)	S—Pt	=	— 0.018 ± 0.021	“ 12 “
4)	A—Br	=	— 0.084 ± 0.027	“ 11 “
5)	S—Br	=	— 0.060 ± 0.035	“ 17 “
6)	Pt—Br	=	— 0.048 ± 0.037	“ 15 “
7)	A—Ll	=	— 0.108 ± 0.016	“ 12 “
8)	S—Ll	=	— 0.160 ± 0.010	“ 19 “
9)	Pt—Ll	=	— 0.162 ± 0.043	“ 20 “
10)	A—Pz	=	+ 0.019 ± 0.047	“ 11 “
11)	S—Pz	=	— 0.056 ± 0.053	“ 18 “
12)	Pt—Pz	=	— 0.096 ± 0.051	“ 19 “
13)	A—Gr	=	— 0.138 ± 0.033	“ 11 “
14)	S—Gr	=	— 0.094 ± 0.012	“ 20 “
15)	Pt—Gr	=	— 0.086 ± 0.037	“ 21 “
16)	A—Pd	=	— 0.018 ± 0.016	“ 12 “
17)	S—Pd	=	+ 0.014 ± 0.032	“ 17 “
18)	Pt—Pd	=	— 0.050 ± 0.032	“ 21 “
19)	A—Y	=	— 0.192 ± 0.027	“ 13 “
20)	S—Y	=	— 0.172 ± 0.027	“ 20 “
21)	Pt—Y	=	— 0.195 ± 0.020	“ 21 “
22)	A—J	=	— 0.088 ± 0.021	“ 13 “
23)	S—J	=	— 0.080 ± 0.020	“ 20 “
24)	Pt—J	=	— 0.107 ± 0.026	“ 22 “
25)	Y—J	=	+ 0.090 ± 0.023	“ 30 “

These equations, combined by weights and solved by least squares when necessary, lead to the following results for circumpolar stars :

From	1)	A—S	=	0.000
	2, 3)	A—Pt	=	— 0.018
	4, 5, 6)	A—Br	=	— 0.073
	7, 8, 9)	A—Ll	=	— 0.151
	10, 11, 12)	A—Pz	=	— 0.045
	13, 14, 15)	A—Gr	=	— 0.116
	16, 17, 18)	A—Pd	=	— 0.020
	19 - 25)	{ A—Y	=	— 0.191
		{ A—J	=	— 0.094,

which require application *in addition* to the corrections previously deduced and applied. For the avoidance of too great prolixity, I have, as already mentioned, deviated slightly from the regular order of the investigation, by giving in the preceding table of proper-motions the values which result after the application of an approximate value of this additional correction to BRADLEY'S places, so that the right-ascensions of the *Fundamenta* were in fact diminished by 0".106 instead of 0".033.

Synoptical tables may now be constructed, showing the right-ascension and declination of each star for 1855.0 as indicated by the different authorities after the application of the proper motions already determined, and of the additional corrections to the right-ascension in the boreal regions as just deduced.

For the definite determination of the places adopted, only those authorities, six in all, are employed which give results of observations made within thirty years. This line of demarcation is indicated in the typography. To ascertain the most proper mode of combination, I proceeded as follows : Taking the arithmetical mean of the right-ascensions used, the discordances of the several authorities were deduced : their mean variation from the arithmetical mean of all was treated as a mean error, and employed to indicate the respective weights. This gave :

Authority.	Mean Discordance.	Corresponding Weight.
Struve	± 0.100	100
Argelander	± 0.055	333
Pond	± 0.135	55
Peters	± 0.120	69
Airy	± 0.128	61
Johnson	± 0.138	53

The adopted places given in the table were therefore obtained by assigning to places from ARGELANDER a quadruple, and to those from STRUVE a double weight. The same rule was followed for the declinations.

The tables are now appended, together with the resultant places and their mean errors. These places, with the exception of the right-ascensions of the four polar stars as above mentioned, are adopted as the results of the present discussion.

SYNOPTICAL TABLE OF RIGHT-ASCENSIONS FOR 1855.

	1. 21 <i>Cassiopeæ</i> .	2. <i>Polaris</i> .	3. <i>α Cassiopeæ</i> .	4. 50 <i>Cassiopeæ</i> .	5. <i>ι Cassiopeæ</i> .	6. 48 <i>Cephei</i> .
Bradley	0 ^h 36 ^m [6°.90]	1 ^h 6 ^m 30°.01	1 ^h 20 ^m 30°.60	1 ^h 51 ^m 8°.86	2 ^h 17 ^m 10°.59	
Lalande	8.58	29.60	31.31	8.31	10.52	3 ^h 2 ^m 5°.31
Piazzi	8.78	32.03	30.23	8.46	11.09	5.77
Groombridge	8.00	32.07	30.38	8.53	10.57	4.56
Struve	8.32	29.83			10.59	
Argelander				8.54		
Pond		29.50	30.63	8.60	10.43	5.23
Peters				8.68		
Airy		29.82	30.68	8.81	10.61	
Johnson	8.77	31.07		8.43	10.65	5.53
	0 ^h 36 ^m 8°.47 ±0°.237	1 ^h 6 ^m 30°.01 ±0°.348	1 ^h 20 ^m 30°.66 ±0°.026	1 ^h 51 ^m 8°.59 ±0°.070	2 ^h 17 ^m 10°.57 ±0°.048	3 ^h 2 ^m 5°.38 ±0°.150
	7. <i>α Camelopardalis</i> .	8. Groombridge 966.	9. 22 <i>Camelopard.</i>	10. 51 <i>Cephei</i> .	11. Piazzi VII. 67.	12. 3 <i>Ursæ Majoris</i> .
Lalande		5 ^h 20 ^m 21°.79			7 ^h 15 ^m 44°.78	19.39
Bradley				6 ^h 31 ^m 6°.11		7 ^h 58 ^m 19°.55
Piazzi	4 ^h 39 ^m 39°.59		6 ^h 2 ^m 51°.73	2.63	45.55	
Groombridge	39.71	21.68	51.32	8.27	45.00	19.37
Struve	39.61					
Argelander						
Pond	39.51	[22.48]	51.58	4.03	45.13	[20.47]
Peters	39.70		51.58		45.00	
Airy	39.37	21.66	51.46	5.24	45.10	19.52
Johnson	39.83	21.87	51.60	5.81	45.14	19.33
	4 ^h 39 ^m 39°.60 ±0°.079	5 ^h 20 ^m 21°.76 ±0°.105	6 ^h 2 ^m 51°.55 ±0°.032	6 ^h 31 ^m 5°.04 ±0°.532	7 ^h 15 ^m 45°.09 ±0°.032	7 ^h 58 ^m 19°.42 ±0°.095
	13. <i>σ² Ursæ Majoris</i> .	14. 1 <i>Draconis</i> .	15. 24 <i>Ursæ Majoris</i> .	16. 32 <i>Ursæ Majoris</i> .	17. 9 <i>Draconis</i> .	18. λ <i>Draconis</i> .
Bradley	8 ^h 57 ^m 34°.50		9 ^h 21 ^m 35°.00	10 ^h 7 ^m 26°.88	10 ^h 22 ^m 39°.00	11 ^h 22 ^m 41°.57
Lalande	33.91	9 ^h 15 ^m [56°.27]	34.66	26.76	38.64	44.48
Piazzi	31.51	61.53	35.66	27.57	38.07	45.22
Groombridge	33.69	60.61	35.00	26.80	37.69	44.82
Struve	34.30					44.59
Argelander						
Pond		[60.38]	35.21		39.03	44.70
Peters		60.81		26.89	38.48	44.61
Airy	31.23	61.31	34.92	26.83	38.59	44.65
Johnson	31.35	61.18	34.78	26.93	38.77	44.58
	8 ^h 57 ^m 34°.30 ±0°.035	9 ^h 16 ^m 1°.12 ±0°.117	9 ^h 21 ^m 34°.97 ±0°.126	10 ^h 7 ^m 26°.88 ±0°.030	10 ^h 22 ^m 38°.72 ±0°.120	11 ^h 22 ^m 41°.62 ±0°.022
	19. 4 <i>Draconis</i> .	20. κ <i>Draconis</i> .	21. 32 <i>Camelop.</i> (foll.)	22. α <i>Draconis</i> .	23. 5 <i>Ursæ Minoris</i> .	24. β <i>Ursæ Majoris</i> .
Bradley	12 ^h 5 ^m 20°.93	12 ^h 27 ^m 16°.28	12 ^h 48 ^m 7°.40	14 ^h 0 ^m 28°.05	14 ^h 27 ^m 53°.19	14 ^h 51 ^m 10°.44
Lalande	21.29	15.70	[8.83]	27.51	53.14	10.38
Piazzi	[21.92]	15.93	6.57	27.75	[53.95]	10.75
Groombridge	20.45	16.17	6.56	28.02	53.15	10.15
Struve		16.02	7.07	27.74	53.17	10.49
Argelander				27.86	53.06	10.40
Pond	20.85	16.17	7.61	27.86	53.00	10.37
Peters	20.77	15.97		27.88		10.32
Airy	20.95	16.11	7.03	27.86	53.11	10.54
Johnson	21.22	16.06	6.95	27.89	53.23	10.48
	12 ^h 5 ^m 20°.95 ±0°.098	12 ^h 27 ^m 16°.06 ±0°.035	12 ^h 48 ^m 7°.15 ±0°.151	14 ^h 0 ^m 27°.84 ±0°.022	14 ^h 27 ^m 53°.10 ±0°.041	14 ^h 51 ^m 10°.43 ±0°.035

SYNOPTICAL TABLE OF RIGHT-ASCENSIONS—(CONCLUDED).

	25. <i>γ</i> ² <i>Ursæ Minoris</i> .	26. <i>ζ</i> <i>Ursæ Minoris</i> .	27. Groombridge 2320	28 15 <i>Draconis</i> .	29. <i>ε</i> <i>Ursæ Minoris</i> .	30. <i>ω</i> <i>Draconis</i> .
Bradley					17 ^h 0 ^m 58.83	17 ^h 37 ^m 48.28
Lalande	15 ^h 20 ^m 59.69	15 ^h 49 ^m 19.89	16 ^h 5 ^m 56.36	16 ^h 28 ^m 16.80	59.82	48.17
Piazzi	59.17	19.84		17.50	[57.57]	48.33
Groombridge	59.26	[18.70]	56.78	17.10	59.20	48.18
Struve	59.62	19.81			59.07	
Argelander	59.55	19.75				48.21
Pond	59.37	19.92	56.46	17.30	58.81	48.35
Peters	59.19	19.77		17.12	59.29	48.22
Airy	59.32	19.87	56.37	17.17	59.26	48.21
Johnson	59.57	20.00	56.64	17.13	58.87	48.19
	15 ^h 20 ^m 59.52 ± 0.051	15 ^h 49 ^m 19.82 ± 0.041	16 ^h 5 ^m 56.49 ± 0.079	16 ^h 28 ^m 17.18 ± 0.041	17 ^h 0 ^m 59.06 ± 0.098	17 ^h 37 ^m 48.23 ± 0.028
	31. <i>ψ</i> ¹ <i>Draconis</i> pr.	32. <i>δ</i> <i>Ursæ Minoris</i> .	33. 50 <i>Draconis</i> .	34. <i>δ</i> <i>Draconis</i> .	35 <i>τ</i> <i>Draconis</i> .	36. <i>ε</i> <i>Draconis</i> .
Bradley	17 ^h 41 ^m 31.66	18 ^h 19 ^m 6.89	18 ^h 51 ^m 1.70	19 ^h 12 ^m 30.47	19 ^h 18 ^m 18.70	19 ^h 48 ^m 38.68
Lalande	30.87	7.26	1.27	30.76	19.28	38.48
Piazzi	31.58	[4.88]	0.34	30.58	18.97	38.11
Groombridge	31.53	8.11	1.30	30.71	18.83	38.60
Struve	31.24	6.45		30.57		38.37
Argelander	31.45			30.61		
Pond	[35.65]	7.22	1.59	30.61	19.01	38.44
Peters				30.56	18.75	
Airy	31.47	6.94		30.47	18.92	38.69
Johnson	31.35	7.13	1.45	30.55	18.68	38.39
	17 ^h 44 ^m 31.39 ± 0.053	18 ^h 19 ^m 6.84 ± 0.180	18 ^h 51 ^m 1.52 ± 0.070	19 ^h 12 ^m 30.59 ± 0.026	19 ^h 18 ^m 18.84 ± 0.076	19 ^h 48 ^m 38.45 ± 0.075
	37. <i>λ</i> <i>Ursæ Minoris</i> .	38. <i>κ</i> <i>Cephei</i> .	39. Groombridge 3241	40. T.Y.C. 1879.	41. <i>β</i> <i>Cephei</i> .	42. 11 <i>Cephei</i> .
Bradley	20 ^h 8 ^m 29.75	20 ^h 13 ^m 41.06		20 ^h 51 ^m 1.11	21 ^h 26 ^m 46.38	21 39 ^m 47.35
Lalande	33.33	41.47	20 ^h 30 ^m 35.49	[2.27]	46.28	46.59
Piazzi	[24.54]	[38.65]	35.58		46.08	46.41
Groombridge	33.75	41.02	36.22	[2.80]	46.42	46.94
Struve	29.94	41.39			46.32	
Argelander	30.36			1.12	46.30	
Pond		41.15	35.91	1.19	46.26	46.97
Peters					46.35	
Airy	31.53	40.97		0.95	46.23	47.31
Johnson	30.41	41.12	35.56	1.04	46.30	46.68
	20 ^h 8 ^m 30.41 ± 0.351	20 ^h 13 ^m 41.20 ± 0.091	20 ^h 30 ^m 35.74 ± 0.175	20 ^h 51 ^m 1.09 ± 0.053	21 ^h 26 ^m 46.30 ± 0.017	21 39 46.99 ± 0.182
	43. 79 <i>Draconis</i> .	44. 226 <i>Cephei</i> .	45. <i>ι</i> <i>Cephei</i> .	46. <i>ο</i> <i>Cephei</i> .	47. <i>γ</i> <i>Cephei</i> .	48. Groombridge 4163
Bradley	21 ^h 51 ^m 3.97		22 ^h 44 ^m 31.69	23 ^h 12 ^m 41.37	23 ^h 33 ^m 25.84	
Lalande	3.55	22 ^h 29 ^m 42.31	31.60	41.61	26.16	23 47 ^m 49.40
Piazzi	3.47		31.46	41.31	25.45	
Groombridge	4.67	42.74	31.66	41.67	26.11	49.44
Struve			31.62	41.49	25.94	
Argelander			31.60		25.89	
Pond		42.84	31.56		25.96	49.96
Peters		42.45	31.67		25.89	
Airy	3.86		31.71	41.33	25.81	
Johnson	3.56	42.49	31.53	41.32	25.77	49.30
	21 ^h 51 ^m 3.71 ± 0.150	22 ^h 29 ^m 42.59 ± 0.124	22 ^h 44 ^m 31.61 ± 0.028	23 ^h 12 ^m 41.41 ± 0.059	23 ^h 33 ^m 25.89 ± 0.031	23 47 49.63 ± 0.330

To be continued.

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ON THE ORBIT OF THE FOURTH COMET OF 1825.

By PROFESSOR J. S. HUBBARD.

I SEND for the *Astronomical Journal* the results of an investigation commenced some five or six years ago, and continued until now, amid many interruptions and with long intervals of other occupations,—trusting that the work thus mosaicked together may not be found entirely wanting in unity.

1.

THIS comet was discovered by PONS, on the 15th of July, 1825, in *Taurus*, while searching for ENCKE's Comet, for which it was at first mistaken;—and also independently by BIELA, on the 19th. and by DUNLOP, at Paramatta, on the 21st of the same month. It was at first very small, having only a faint nucleus, with a trace of a tail, and throughout the month of August presented nothing worthy of notice, except that from the first its form seemed subject to change, sometimes appearing elongated and at others entirely round. As the tail developed, it also manifested variations in form and direction, being curved, now convex toward the north, after some days entirely straight, and then curved in the opposite direction. In September, the comet's rapid approach to the earth was indicated by a corresponding increase of brilliancy and velocity, and its changes were more strongly marked; but it was in October, near the perigee (Oct. 11, distance from earth = 0.618), that its peculiar phenomena were most strikingly presented. PONS says of it,⁽¹⁾ on the 11th, that "it was in grand costume, never before so elegant;—with trailing robe, it only needs arms to resemble a lady of high rank of the past century." On the 12th it had rather increased than diminished in light, while on the 13th "its adornings appeared to have fallen to rags," and on the next night it "seemed to have a new robe without rent; it was modestly veiled like a nun."—From the changes of direction and form noted and represented by DUNLOP,⁽²⁾ this astronomer was led to infer a rotation of the comet upon its axis, with a period of $19^h 36^m$. The length of the tail was continually varying; its maximum was about

12° . It was divided into two, and sometimes three branches, separated by a wide void space, each branch seeming to have a tendency to continued subdivision. Its light was undulating, or, as described by one observer, pulsating.

The nucleus during this appearance was always bright, sometimes diffuse and sometimes star-like. HERSCHEL states⁽³⁾ that this latter appearance was, in his twenty-foot reflector, transformed into that of an irresolvable planetary nebula, very suddenly but not abruptly much brighter in the middle, and with a diameter of $10''$ or $15''$ on the 4th, and of $15''$ or $20''$ on the 7th of October. SANTINI says⁽⁴⁾ that, on the 6th of the same month, the nucleus seemed as though composed of three brilliant points. The nucleus was not always in the center of the coma, but varied in position from one side, opposite the sun, to the other, at irregular intervals.

The comet was followed by the European observers until the 20th of October, and by DUNLOP as late as December 24,—thirteen days after the perihelion passage.

Returning northward, and again approaching the earth, it was refound by PONS on the 2d of April, 1826, "but," says he,⁽⁵⁾ "in what a condition! It has been totally ruined among our antipodes; it has neither tail nor beard, neither envelope nor nucleus,—it is only a ghost, a white smoke!" It increased a little in brightness, but was always vague and diffuse, though still manifesting its wonted variability;—it was nearest the earth on the 24th of April, but was observed by INGHIRAMI as late as the 8th of July, after which it finally disappeared.

⁽¹⁾ *Corr. Astr.*, XIII. 489 et seqq.

⁽²⁾ *Edinburgh Journal of Science*, VI. Art. X.

⁽³⁾ *Mém. R. Ast. Soc.*, II. 486.

⁽⁵⁾ *Corr. Astr.*, XIV. 404.

⁽⁴⁾ *Corr. Astr.*, XIII. 590.

2.

The appearance of so brilliant a comet naturally incited, not only to diligent observation, but also to manifold attempts at determining its true path in the heavens. The most accurate orbit, and, so far as I know, the only one based upon observations made on both sides of the perihelion, is the ellipse computed by HANSEN from normals dated 1825, Sept. 10.5, Oct. 2.5, and 1826, May 9.5. Its elements are ⁽¹⁾ : —

M. T. Greenwich. Mean Equinox 1825, Dec. 11.

Time of Perihelion Passage	=	$T = 1825, \text{ Dec. } 10.68187$
Long. of Ascending Node	=	$\Omega = 215^{\circ} 43' 13.9''$
Dist. of Perihelion from Node	=	$\omega = 256 \ 56 \ 32.4$
Inclination to Ecliptic	=	$i = 146 \ 27 \ 20.7$
Log. Perihelion Distance	=	$\log q = 0.0937189$
Eccentricity	=	$e = 0.9953690$

We have also relatively to the equator :

Right-Ascension of Ascending Node	=	$\Omega_0 = 203^{\circ} 27' 37.32''$
Distance of Perihelion from Node	=	$\omega_0 = 240 \ 16 \ 23.55$
Inclination to Equator	=	$i_0 = 125 \ 52 \ 9.46$

This orbit reproduces the data "within a few seconds," but when subjected to more extended comparison, exhibits larger and systematic deviations. Inasmuch, therefore, as the whole series of observations, extending over an unusually large interval of time, seem to promise, not only by their number, but also by the variety of method and circumstances under which they were made, a peculiarly accurate determination of the orbit, I have undertaken the present discussion, partly in order to obtain the small corrections needed by the above elements, but more especially from curiosity to learn whether a comet so large and so capricious as this would prove entirely subversive to the law of gravitation alone.

3.

From all available sources, I have collected as many observations as could be found, and subjected them to scrutiny more or less extended, as the cases seemed to require, and the results are as follows.

Åbo. (ARGELANDER.) *Observationes Astronomicae*, Tomus I. — 1824, 1825.

Nearly all these observations were made with a Fraunhofer telescope of five-and-a-half feet focal distance, using the diaphragm of the eye-piece as a ring-micrometer. On one occasion (Aug. 25) a four-foot Dollond telescope was also used in the same manner; and we have in addition two determinations with a three-and-a-half foot Fraunhofer heliometer. I have reduced anew the observations in order to apply requisite corrections to the assumed star-places, correcting also as usual for refraction, and for the comet's motion while passing through the field, for parallax and aberration. By comparison with other observations, it would seem that the result always to be apprehended from the use of a simple diaphragm in comet-observations has been here produced; namely, that, while the star-transits may be accurately noted, the observer rarely succeeds in determining the exact time of the comet's entrance into the field, generally giving it too late, and consequently making both the resulting right-ascension and distance from center of field too great. The former error is incorrigible; the latter may be compensated by taking the comet-transits both in the upper and lower parts of the field, as has been done in the present case, except in two instances. That the effect, though traceable, is no greater, is due to the excellence of the observer, who was doubtless fully awake to the liability of such observations to produce it.

Ring-Micrometer.

M. T. Greenwich.	α	δ	C. — O.		No. of Comp.	
			$\Delta \alpha$	$\Delta \delta$	α	δ
1825, Aug. 21.42633	$63^{\circ} 45' 31.0''$	$+21^{\circ} 42' 56.8''$	— 3.4	— 19.5	1	1
22.44365	$63 \ 43 \ 3.2$	$21 \ 28 \ 23.8$	— 15.0	+ 12.9	9	9
23.45003	$63 \ 39 \ 56.5$	$21 \ 14 \ 9.2$	— 21.5	+ 1.6	6	6
24.44406	$63 \ 35 \ 55.9$	$20 \ 59 \ 19.8$	— 7.8	+ 0.7	6	6
25.50777	$63 \ 31 \ 12.0$	$20 \ 43 \ 3.6$	— 7.6	— 16.2	7	7
31.54781	$62 \ 48 \ 27.6$		+ 7.8		4	
.54911		$+18 \ 53 \ 7.7$		+ 1.2		3

⁽¹⁾ *Astr. Nachr.*, V. 32.

M. T. Greenwich.	α	δ	C. — O.		No. of Comp.	
			$\Delta \alpha$	$\Delta \delta$	α	δ
1825, Sept. 6.42932	61° 35' 25.5"	+16° 33' 13.9"	— 1.5	+ 2.8	7	7
7.39088	61 19 59.8	16 6 31.9	— 22.9	— 9.8	6	6
11.42218	59 59 23.5	13 57 52.7	+ 6.2	+ 3.4	3	3
12.37912	59 36 56.4		— 14.5		11	
.38162		+13 22 43.5		+23.8		10
28.44131	47 26 26.8	— 2 59 54.0	— 27.5	+ 0.5	5	5
29.39307	46 12 17.4	4 31 41.5	— 8.8	— 0.4	6	6
Oct. 2.47158	41 38 22.6	10 0 34.0	— 13.5	+12.3	9	8
5.41315	36 19 37.1	— 15 55 38.1	— 17.8	+ 3.0	7	7
<i>Heliometer.</i>						
Sept. 7.48604	61 18 16.9	+16 3 21.0	— 17.6	+14.1	6	
12.48777	59 34 6.3	+13 18 59.5	— 5.7	+ 9.9	13	

Altona. (SCHUMACHER.) *Astronomische Nachrichten*, V. 39, 57.

Double-Ring Micrometer.

M. T. Greenwich.	α	δ	C. — O.		No. of Comp.	
			$\Delta \alpha$	$\Delta \delta$	α	δ
1825, Aug. 23.54471		+21° 12' 45.4"		+ 2.2		4
.51643	63° 39' 12.9"		+ 1.8		4	
30.58572	62 57 16.8		+ 2.1		4	
.59094		19 12 12.4		+19.3		2
Sept. 11.48976	59 57 50.0		+ 6.3		3	
.49558		+13 55 23.1		— 3.1		2
27.55788	48 30 25.8		— 2.5		4	
.56194		— 1 39 32.9		+22.2		4
Oct. 1.48960	43 11 42.4		+ 1.5		5	
.49705		8 11 25.8		+15.9		4
1826, May 8.47522	220 14 44.5	29 5 22.7	+28.5	+42.1	2	2
9.45204	219 15 52.0		— 6.7		6	
.46559		28 30 3.1		+ 8.3		5
10.42174	218 17 57.3		+20.6		2	
.42255		27 56 5.2		— 12.7		2
13.44441	215 29 36.8		— 15.8		4	
.45661		— 26 10 12.1		— 4.1		3
<i>Meridian-Circle.</i>						
1825, Oct. 1.55886	43 5 27.0	— 8 18 5.4	— 7.2	+ 8.2	2 threads.	
2.55182	41 29 58.5	10 9 31.0	+15.4	— 2.7	6	"
3.54451	39 48 52.5	12 5 51.5	— 6.9	+ 5.3	6	"
5.52890	36 5 36.0	16 10 18.7	— 4.5	+ 5.4	6	"
8.50289	29 36 42.0	— 22 36 1.8	— 10.3	— 10.4	5	"

The observations at Augsburg, given in the *Berliner Astronomisches Jahrbuch*, for 1829, p. 189, are evidently affected with very gross errors, so as to be entirely unavailable.

Bremen. (OLBERS.) *Astr. Nachr.*, IV. Circular to No. 83, p. 222; V. 265.

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta \alpha$	$\Delta \delta$
1825, Aug. 9.48211	63° 39' 52.5"	+23° 51' 0.9"	+ 1.1	— 71.9
Sept. 1.47193	62 39 8.5	18 33 36.0	17.2	+ 4.3
8.46948	61 0 9.2	15 34 46.6	21.1	— 11.3
9.45276	60 41 2.0	15 4 4.8	37.8	— 2.0
10.45743	60 20 39.0	14 30 28.9	16.1	+41.9
11.44953	59 58 26.8	+13 57 11.1	+25.2	— 13.1

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta \alpha$	$\Delta \delta$
1825, Sept. 13.47787	59° 9' 7".0	+12° 42' 58".2	— 36".7	—115".1
14.41849	58 42 20.4	12 3 12.7	+ 12.2	— 20.5
15.48573	58 13 24.0	11 16 32.5	—149.0	+ 30.3
18.52771	56 26 46.9	+ 8 49 51.9	— 8.9	+ 9.1
28.47003	47 23 46.7	— 3 2 6.9	+ 3.0	— 29.0
29.45359	46 7 27.2	4 36 52.6	— 10.2	— 49.0
30.46383	44 43 1.6	6 19 59.1	+ 8.9	— 34.4
Oct. 1.44864	43 15 20.2	8 4 38.8	+ 10.1	— 73.1
2.44763	41 40 41.3	9 57 51.4	— 10.9	+ 13.8
3.43855	39 59 44.1	11 52 58.0	+ 10.2	— 11.4
5.42330	36 18 13.8	15 56 5.3	— 6.9	— 46.5
6.45059	34 11 58.2	18 6 52.7	+ 8.9	— 76.1
8.41200	29 44 44.5	—22 28 5.0	+ 25.6	— 7.2

(oburg. (GÜBEL.) *Astr. Nachr.*, IV. 293.

I have not reduced the observations of September 17 and 20, of which only the original record is here given, the comparison-stars being unknown.

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta \alpha$	$\Delta \delta$
1825, Sept. 10.41715	60° 21' 36".0	+14° 38' 42".0	+ 7".9	—37".7
11.40146	59 58 5.0	+13 57 30.0	+110.1	+ 65.6
13.39650	59 8 59.0	+12 45 59.7	+ 98.1	—108.7
Oct. 5.40031	36 20 54.7	—15 54 58.8	— 20.4	+ 34.1
.40161				

Florence. (INGHIRAMI.) *Correspondance Astronomique*, XIV. 285, and *Astr. Nachr.*, V. 25, 49, 145.

These observations were made with a five-foot Fraunhofer telescope, and double ring-micrometer. I have carefully reduced them from the originals, assuming the corrections given below, and applying all the usual astronomical corrections. It is greatly to be regretted that for many dates, and especially in October, 1825, and July, 1826, the declinations are entirely indeterminate, the transits of comet or star having been taken too near the center of the field.

Corrigenda in Corr. Astr., XIV. 285 et seqq.

1825.
 July 29 First obs. of star, for 33 34.0 read 33 54.0.
 Aug. 3 " " of comet, " 11 47.2 " 11 37.2.
 9 Second obs. of star corresponds with first observation of comet, Aug. 10.
 12 Something wrong in the record. The given times of egress from both circles in the first observation are identical with the times of ingress in the second; and the mean time given among the published results (*C. A.* XIII. 184) cannot be deduced from this record at all.
 17 Last obs. of star, for 43 34.0 read 43 24.0.
 25 First " comet, " 59.2 " 5 9.2.
 Sept. 16 Second " comet, " 53 14.4 " 53 54.4.
 21 Second " *u' Tauri*, " 57 14.4 " 57 54.4.

- Sept. 22 Some error of record, as the published results give an accordant α (*C. A.* XIII. 488). I have increased the resulting α by 5".
 23 First obs. of star, for 55 57.6 read 55 27.6.
 25 First obs. of comet, for 14 read 15 for both rings.
 29 Last obs. of comet belongs with first observation of star, Sept. 30.
 29 Diminished resulting α by 10".
 Oct. 1 For 5.1 and 5.2 *Eridani*, read φ .1 and φ .2 *Eridani*.
 10 Last obs. of star, for 8 10.8 read 18 10.8.

Corrigenda in Astr. Nachr., V. 25, 49, 145.

1826.
 May 1 For λ *Lupo*, read χ *Lupo*.
 7, 8 " δ *Lupo*, " 2 *Lupo*.
 11 Last obs. of 6 *Librae*, for 30 59.6 read 29 59.6.
 13 First " 31 *Hydrae*, " 23 58.8 " 22 58.8.
 16 Col. " *Equaz. dell' Orlogio*, insert +2" 58".4.
 30 Third obs. of comet, for 38 57.2 read 37 57.2.
 June 1 Third " comet, " 21 59.2 " 20 59.2.
 6 Third " comet, " 20 20.0 " 21 20.0.
 " " comet, " 20 7.2 " 21 7.2.
 12 For *i Vergine* read Lal. 24990.
 Second obs. of comet, for 32 read 31 for both rings.
 23 First " comet, for 58 19.6 read 58 49.6.

June 25 Second obs. of comet, for 15 46.8 read 14 46.8.
 26 Fourth " comet, " 30 52.0 " 30 47.0.
 Obs. of 49 *g Virginis* belongs with first series of
 June 27.
 28 For 58 *Vergine*, read 50 *Vergine*.
 " Last obs. of star, for 24 57.2 read 28 57.2.
 " Last " star, " 23 42.0 " 28 42.0.
 29 Second " star, " 31 read 30 for both rings.
 July 2 Second " comet, read 48 52.4 52 2.4 49 7.8
 51 48.8.

July 3 First obs. of comet, for 50 18.4 read 50 28.4.
 " " comet, " 50 30.8 " 50 40.8.
 4 Second " comet, " 21 23.2 " 22 3.2.
 " " comet, " 21 8.0 " 21 48.0.
 5 Second " star, " 6 46.0 " 6 36.0.
 " " star, " 6 58.4 " 6 48.4.
 Second " comet, " 11 27.6 " 10 27.6.
 8 Second " comet, " 50 30.0 " 59 30.0.

M. T. Greenwich.		α	δ	$\Delta\alpha$	$\Delta\delta$	No. of Comp.	
		α	δ	$\Delta\alpha$	$\Delta\delta$	α	δ
1825, July	29.59201 ⁽¹⁾	62° 50' 56".2	+25° 12' 32".3	+75".0	+ 44.2	2	2
Aug.	3.58662 ⁽¹⁾	63 16 49.7	24 39 35.3	+67.4	+ 11.1	3	3
	9.51695	63 39 28.1	23 51 49.5	+31.5	+ 41.1	1	1
	10.53906	63 42 57.0	23 43 24.9	-15.4	- 1.5	2	2
	11.54748	63 44 55.5		+ 4.5		1	
	13.50313	63 48 23.8	23 14 57.4	+ 1.0	+ 6.2	2	2
	15.52445	63 50 29.5	22 54 5.2	- 7.7	- 6.6	3	3
	16.61882		22 41 59.4		- 5.1		1
	.62079	63 50 50.5		- 8.4		2	
	17.54273	63 50 36.4		- 2.4		5	
	.55433		22 30 50.3		+ 21.4		2
	18.53328	63 50 23.3	22 19 37.3	-24.4	- 2.6	3	3
	22.56838	63 42 37.7		-11.5		1	
	.56985		21 26 2.8		+ 47.1		1
	23.56497	63 39 17.8	21 12 11.6	- 7.1	+ 18.1	1	1
	24.54817	63 35 33.8		-11.6		3	
	25.57733	63 31 3.3	20 41 2.4	-19.8	+ 38.2	2	2
	26.56778	63 25 24.8		+10.4		3	
	27.52086	63 19 57.8		+ 1.8		1	
Sept.	6.45729	61 35 3.3	16 32 14.0	- 8.8	+ 16.8	2	2
	7.44037	61 18 59.9		-13.6		1	
	10.43035	60 21 48.2		-18.3		3	
	11.42821	59 59 12.0	13 57 13.3	+ 9.4	+ 30.0	2	2
	16.44566	57 40 36.9	10 33 9.5	-14.8	+ 14.2	3	3
	17.43310	57 7 5.1		-21.4		3	
	18.42720	56 30 42.6		-15.9		2	
	.43081		8 54 35.9		+ 30.7		3
	19.49984	55 48 51.0	7 56 51.7	-28.0	+ 25.2	1	1
	20.43207	55 9 21.7	7 3 23.9	- 9.2	+ 23.7	2	2
	21.44589	51 23 37.8	6 2 15.2	+ 1.2	- 4.8	2	2
	22.41061	53 37 15.1	4 59 29.4	- 0.4	+ 29.7	1	1
	23.45152	52 43 40.4		- 4.0		2	
	24.44954	51 48 40.1		-13.2		2	
	25.44225	50 49 57.0	+ 1 19 41.7	-14.4	+ 0.8	3	3
	26.43193	49 47 24.9		-22.4		3	
	28.46010	47 24 47.9	- 3 2 10.1	-13.3	+ 30.4	3	3
	29.42318	46 10 18.7		-35.1		2	
	.43752	8 28.1		+ 6.4		1	
	30.41487	44 47 54.2	6 15 50.0	-31.2	+ 22.9	3	3
Oct.	1.37067	43 21 31.8		-19.4		4	
	2.38045	41 47 22.2		-16.7		2	
	5.42182	36 18 44.3		-26.8		4	
	.43709		15 58 33.6		- 2.8		3
	6.41237	34 17 15.9	18 3 3.1	-18.7	- 9.5	2	2
	7.43564	32 1 9.6	-20 16 26.8	-18.6	+ 14.0	2	2
	9.42177	27 23 9.8		-27.2		2	
	10.44610	24 46 35.6		-32.6		2	

(1) Observed by PONS.

M. T. Greenwich.		α		δ	$\Delta\alpha$	$\Delta\delta$	No. of Comp.	
							α	δ
1825, Oct.	11.39718	22° 14'	26".7		—40".6		2	
	12.39341	19 28	9.6		—33.0		2	
	13.41883	16 30	30.2		—24.5		1	
	17.37647 ⁽¹⁾	4 21	35.6		—26.4		2	
1826, Apr.	6.61904	259 33	49.8	—41° 10' 36".8	+45.8	+ 64".8	1	1
	15.60720	248 35	51.1	39 36 10.9	+57.6	+ 60.7	1	1
	16.58922	247 19	42.2		+31.2		2	
	18.59738	244 41	52.8		+ 3.7		1	
May	.62373	40	9.6		—18.4		1	
	1.43696	228 7	57.7		— 2.7		2	
	.46167			33 3 37.3		0.0		1
	2.45443	226 55	22.3		—14.6		1	
	7.43050	221 20	43.4		—10.4		2	
	8.39784	220 20	14.6		—14.8		2	
	11.39417			27 22 17.4		+ 4.8		3
	.40714	217 21	36.6		— 4.8			
	12.35121	216 28	37.9		+ 2.6		3	
	.36189			26 48 25.3		+ 3.6		2
	13.35889	215 34	21.9		—26.9		2	
	16.42074	212 58	13.4	24 28 53.4	—15.5	+ 7.6	3	3
	28.36671	205 8	0.8	18 23 37.1	+33.4	+ 42.7	2	2
	29.35078	204 38	39.2	17 56 33.4	+ 3.3	— 5.1	4	4
	30.35363	204 9	38.9	17 30 33.9	— 9.2	+ 2.2	3	3
	31.34786	203 41	34.3	17 5 17.3	+ 8.6	0.0	3	3
June	1.34643	203 15	0.8		— 3.0		4	
	6.38449	201 16	31.0		— 7.5		4	
	8.35503 ⁽²⁾	200 36	54.8		— 2.2		3	
	11.40070	199 42	42.1	13 6 10.2	— 5.2	— 44.6	3	3
	12.42029	199 26	40.4	12 48 0.7	—39.0	— 24.7	3	3
	23.37278 ⁽³⁾	197 17	24.0	10 7 16.6	—75.9	+119.3	3	3
	24.37242	197 8	2.9		— 6.6		2	
	25.38825	197 0	41.8	9 41 33.9	—32.4	+ 24.9	3	3
	26.38424	196 53	45.8		—43.3		4	
	27.38534			— 9 18 56.3		+ 7.3		3
	.39116	196 46	17.4		+ 2.6		3	
	28.38513	196 40	29.5		—15.5		3	
July	29.38984	196 34	42.1		—11.1		3	
	30.35690	196 29	34.5		— 7.5		3	
	1.36311	196 25	16.0		—38.9		3	
	2.36025	196 19	54.8		+20.6		2	
	3.36798	196 16	39.7		—23.4		2	
	4.37737	196 12	54.1		—12.8		2	
	5.37838	196 9	9.6		+22.1		3	
	8.36681	196 2	28.5		— 9.9		2	

(To be continued.)

OBSERVATIONS OF PHOCEA AND PANDORA.

MADE WITH THE FILAR-MICROMETER OF THE EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Captain MAURY. — Corrected for refraction.]

PHOCEA.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽²⁵⁾ — *		$\Delta\delta$ ⁽²⁵⁾ 's apparent	
				α	δ	α	δ
1858, Dec. 27	^h 9 ^m 30 ^s 12.1	4	Weisse V. 1530	^m —2 ^s 32.07	+ 9' 50".77	^h 5 ^m 57 ^s 9.72	—4° 1' 2".87
1859, Jan. 8	9 2 52.7	5	" 1200	—1 35.32	+ 5 45.59	5 46 1.47	—3 58 52.39

⁽¹⁾ In the published results three comparisons are mentioned.⁽²⁾ First comp. is discordant, and rejected.⁽³⁾ Rejected.

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
Weisse V. 1530	6	^h 5 ^m 59 ^s 42.97	—4° 11' 0.17"	Weisse's Catalogue.
" 1200	7	5 47 37.90	—4 5 41.67	

PANDORA.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	Planet — Star		Planet's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	⁺ [°] ['] ["]
1858, Nov.	15 7 56 19.5	4	Weisse O. 90	+0 9.91	+ 8' 9.77	0 6 2.55	+ 2° 44' 49.76
	18 7 55 46.5	11	" 110	—1 6.59	+11 54.46	0 6 9.87	2 53 15.92
	19 7 45 7.5	16	" 110	—1 0.90	+14 58.05	0 6 15.56	2 56 19.48
	23 8 16 59.3	9	" 51	+3 3.25	—10 47.48	0 6 55.43	3 10 11.69
	26 8 1 39.0	23	B.A.C. 42	—1 1.49	— 6 12.18	0 7 42.23	3 21 28.20
	30 8 16 7.7	14	" 42	+0 23.09	+11 16.58	0 9 6.79	3 39 26.77
Dec.	9 7 58 5.9	12	Weisse O. 255	—1 26.19	— 0 53.87	0 13 44.21	4 26 17.95
	10 7 13 58.9	14	" 42	—0 49.62	+ 4 28.88	0 14 21.07	4 31 40.66
	16 9 8 58.7	4	Santini 23	—0 25.99	—10 3.95	0 18 37.99	5 8 46.30
	17 8 2 40.7	6	" 23	+0 18.24	— 3 47.56	0 19 22.19	5 15 2.65
	22 8 3 4.1	12	B.A.C. 129	—1 34.56	—21 39.20	0 23 34.35	5 49 0.53
	25 7 51 4.7	11	" 129	+1 8.16	— 0 13.85	0 26 16.05	6 10 25.72
	27 8 20 27.0	7	" 129	+3 3.69	+14 36.74	0 28 11.55	6 25 16.17
		7	Rümker, N.F. 235	—0 35.48	+ 2 26.48	0 28 11.41	6 25 16.75
1859, Jan.	4 8 8 13.5	2	Weisse O. 629	—0 13.93	+ 0 53.39	0 36 27.51	7 27 13.04
	8 7 25 11.4	15	" 686	+1 0.24	+ 7 11.61	0 40 55.65	7 59 41.71
	10 7 31 44.2	3	" 704	+2 24.30	—10 44.67	0 43 16.88	8 16 24.12
	18 8 19 36.0	6	" 950	—1 23.69	+ 6 5.47	0 53 10.18	9 26 1.37
	19 8 23 11.3	10	" 972	—1 14.78	+12 29.57	0 54 27.41	9 34 51.08
	31 7 32 29.0	6	Weisse I. 179	—1 35.10	— 0 24.23	1 10 41.86	+11 23 55.75

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
Weisse O. 90	9	^h 0 ^m 5 ^s 54.99	+ 2° 36' 54.40"	Weisse's Catalogue.
" 110 ⁽¹⁾	9	0 7 18.83	2 41 35.92	
" 51	8	0 3 54.85	3 21 13.82	
B. A. C. 42	8	0 8 46.16	3 28 24.92	B. A. Catalogue.
Santini 23	8.5	0 15 13.22	4 27 26.46	Santini's Catalogue.
Σ Cat. G. 32	6.4	0 19 6.52	5 19 4.90	Struve's Catalogus Generalis.
Rümker, N. F. 235	8	0 25 10.52	6 10 54.19	Rümker Neue Folge.
Weisse O. 629	9	0 28 49.59	6 23 4.81	Weisse's Catalogue.
" 686	8.5	0 36 41.13	7 26 31.01	
" 704	8	0 39 58.14	7 52 44.41	
" 950	9	0 54 38.64	9 20 9.77	
" 972	9	0 53 44.97	9 22 35.28	Weisse's Catalogue.
Weisse I. 179	8	1 14 19.82	+11 24 32.98	

⁽¹⁾ The declination of Weisse O. 110 is erroneous in the Catalogue.

FIRST COMET OF 1859.

LETTER FROM MR. WATSON TO THE EDITOR.

Ann Arbor, 1859, April 25.

I HAVE the pleasure to inform you that I discovered a new, to be considerably elongated in a direction opposite from the Comet at 9 o'clock on the evening of Saturday, the 23d in sun. The following position was observed with the great stant, near the star 17 *Lyncis*. It is quite bright, and seemed equatorial:—

1859.	Ann Arbor M. T.	α	δ	No. of Comp.
Apr. 23	h m s	h m s		
	11 0 40.3	6 58 41.74	+60° 57' 29.9"	8
Daily motion in α , $-7^m 12^s$; in δ , $-1^\circ 50'$.				

Adopted Mean Place 1859.0 of the Comparison-Star.					
Mag.	α			δ	Authority.
	^h	^m	^s		
(7.8)	6	57	5.91	+60° 57' 41.7"	Rümker's Catalogue.
JAMES C. WATSON.					

LETTERS FROM PROFESSOR BOND TO THE EDITOR.

Observatory of Harvard College, Cambridge, April 28th, 1859.

A COMET was discovered last evening at this Observatory, by Mr. H. P. TUTTLE, in the constellation of the Lynx. I have this moment received a letter from Mr. WATSON, at Ann Arbor, stating that it was seen by him on Saturday last.

We obtained good comparisons last evening, which I will communicate as soon as fully reduced.

Approx. A.R. $6^h 35^m 14^s$

" Dec. $+53^\circ 48' 12''$

April 27th, $9^h 34^m$ m. s. t. Camb.

The Comet is bright, and shows a tail of $10'$ in length in a hazy sky. It is moving 2° daily towards the south.

THE reduction of our observations on the comet last evening furnishes the following apparent positions.

April 27 $9^h 33^m 36^s$ Camb. m. s. t.

A.R. $6^h 35^m 18.79^s$

Dec. $+53^\circ 47' 40''.4$

Compared with No. 7170 of Oeltzen's Catalogue, reduced from Argelander's Zones.

G. P. BOND.

ELEMENTS AND EPHEMERIS BY MR. T. H. SAFFORD, CAMBRIDGE.

FROM observations made at Ann Arbor, April 23, and Cambridge, April 27, 29.

T	1859, May 29.0030	Washington.
$\log q$	9.30403	
ω	$281^\circ 59'.66$	
Ω	$357^\circ 41'.77$	M. Eq. April 27.
i	$94^\circ 52'.78$	

The middle observation was represented thus:—

C. — O.

$\Delta \alpha \cos \delta +0'.03$ $\Delta \delta +0'.22$

That at Padua, April 7th, thus:—

$\Delta \alpha \cos \delta -4'$ $\Delta \delta +1'$

Ephemeris. — Washington Mean Time.

1859.	α	δ	$\log. \Delta$	$\log. r$
	h m s			
May 12	$5^h 44^m 34^s$	$+27^\circ 24'.4$	9.9123	9.7620
13	$5^h 41^m 36^s$	$25^\circ 51'.5$		
14	$5^h 38^m 32^s$	$24^\circ 20'.5$	9.9239	9.7210
15	$5^h 35^m 21^s$	$22^\circ 51'.5$		
16	$5^h 32^m 1^s$	$21^\circ 24'.6$	9.9363	9.6748
17	$5^h 28^m 31^s$	$20^\circ 0'.0$		
18	$5^h 24^m 48^s$	$18^\circ 38'.0$	9.9494	9.6221
19	$5^h 20^m 52^s$	$17^\circ 18'.9$		
20	$5^h 16^m 37^s$	$16^\circ 3.3$	9.9632	9.5620
21	$5^h 12^m 3^s$	$14^\circ 51'.7$		
22	$5^h 7^m 6^s$	$13^\circ 45'.0$	9.9778	9.4937
23	$5^h 1^m 42^s$	$12^\circ 44'.5$		
24	$4^h 55^m 48^s$	$+11^\circ 57'.2$	9.9930	9.4190

LETTER FROM MR. ASAPH HALL TO THE EDITOR.

Cambridge, May 23, 1859.

I HAVE computed the following elements of the Comet discovered by Mr. WATSON on April 23.

$T = 1859, \text{ May } 29.2399$ Gr. N. T.

$\pi = 75^\circ 9' 46''.2$ } Mean Eq. 1859.0.

$\Omega = 357^\circ 7' 56''.8$ }

$i = 84^\circ 9' 3.2$

$\log q = 9.303308$

Motion Retrograde.

For the middle place, (computed — observed.)

$d\beta = -11''.0$ $\cos \beta d\lambda = -8''.5$

The elements have been computed from the Ann Arbor observation of April 23, and the Cambridge observations of April 27 and May 2.

ASAPH HALL.

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ON THE ORBIT OF THE FOURTH COMET OF 1825, BY PROFESSOR J. S. HUBBARD.
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NO. 4.

FROM A LETTER OF PROFESSOR CHALLIS TO THE EDITOR.

Cambridge Observatory, 1859, April 21.

I SEND a few observations of *Pandora* and of the Eighth Comet of 1858 for the *Astronomical Journal*, regretting that I have not been able to dispatch them earlier. From the beginning of this year, myself and assistants have been making a great effort to reduce and prepare for the press the Cambridge Meridian and Equatorial Observations of former years, the publication of which is much in arrear. This work so occupies me, that I am obliged, for a time at least, to give up observations of the minor planets. This circumstance I have communicated to the *Astronomische Nachrichten*, and I am desirous also that American astronomers should be informed that I am not now carrying on observations of the eight planets which I selected for especial attention, viz. *Flora*, *Metis*, *Victoria*, *Themis*, *Proserpina*, *Bellona*, *Urania*, and *Leucothea*. I hope that these members of the large family will, nevertheless, receive a due share of attention.

J. CHALLIS.

OBSERVATIONS OF PANDORA, AND OF THE EIGHTH COMET OF 1858.

MADE WITH THE NORTHUMBERLAND EQUATORIAL AT THE CAMBRIDGE OBSERVATORY.

PANDORA.

1858.	Greenwich M. T.	Planet — *			No. Comp.	Star.	App. R. A. of Planet.	Par. × Δ	App. N. P. D.	Par. × Δ
		R. A.	N. P. D.							
	^h ^m ^s	^m ^s					^h ^m ^s	^s	[°] ['] ["]	["]
Oct. 28	11 29 7.0	—1 18.85	— 2' 33.3	1	<i>a</i>	0 10 47.41	+0.158	87 39' 51.2	—6.55	
Nov. 2	12 56 31.4	—3 50.28	— 4 18.1	6	<i>a</i>	0 8 15.96	+0.285	87 38 6.5	—6.62	
17	8 54 48.0	+0 12.59	—13 10.5	14	<i>b</i>	0 6 5.18	+0.054	87 10 9.8	—6.48	
18	8 31 55.0	+0 16.53	—16 6.1	14	<i>b</i>	0 6 9.11	+0.025	87 7 14.2	—6.47	

Assumed Mean Places of the Stars, 1858.0.

*	R. A.	N. P. D.	Authority.
	^h ^m ^s		
<i>a</i>	0 12 2.33	87 42' 50.9	B. (W.) O. 196
<i>b</i>	0 5 48.80	87 23 45.9	B. (W.) O. 90

COMET 1858 VIII.

1858.	Greenwich M. T.	R.A.	 — * N. P. D.	No. Comp.	Star.	App. R.A. of 	Par. $\times \Delta$	App. N. P. D.	Par. $\times \Delta$
	^h ^m ^s	^m ^s	^h ^m ^s			^h ^m ^s	^s	[°] ['] ["]	["]
Oct. 8	11 4 52.3	+1 34.32	+ 4' 25.6	7	<i>a</i>	22 20 55.04	+0.178	69 41' 24.2	—4.72
28	9 41 58.0	+1 11.08	+ 0 34.4	8	<i>b</i>	20 32 24.39	+0.292	102 35 5.0	—7.25
30	7 29 54.3	—0 47.23	+13 55.8	10	<i>c</i>	20 28 38.25	+0.148	103 54 16.7	—7.70
Nov. 2	7 45 45.3	+0 33.32	+ 9 30.6	12	<i>d</i>	20 23 42.76	+0.195	105 41 3.8	—7.70

Assumed Mean Places of the Stars, 1858.0.

*	R. A.			N. P. D.			Authority.		
	^h	^m	^s	[°]	[']	["]	^h	^m	^s
<i>a</i>	22	19	17.37	69	37	22.7	B. Z.	196,	22 18 8
<i>b</i>	20	31	10.12	102	34	37.7	B. (W.)	XX.	786
<i>c</i>	20	29	22.30	103	40	27.4	B. (W.)	XX.	733
<i>d</i>	20	23	6.30	105	31	38.4	Camb.	Observations.	

The place of *d* depends on a single equatorial comparison with τ' *Capricorni* and Arg. Z. 249, No. 65.

ON THE ORBIT OF THE FOURTH COMET OF 1825.

By PROFESSOR J. S. HUBBARD.

(Continued from page 22.)

Florence. (PONS.) *Corr. Astr.*, XIII. 390. 489; XIV. 405, 496, 591.

Observations with a transit-instrument. In 1825. the comet with only very unsatisfactory results. The observations in was observed at its entrance into and exit from the field, and 1826 were taken over the threads in the usual manner. in some cases at the exit only. Omitting these last, I have In the record, the day is supposed to commence at mid-reduced and compared the others, but, as might be anticipated, night.

M. T. Greenwich.	α	$\Delta\alpha$	M. T. Greenwich.	α	$\Delta\alpha$
1825, Sept. 16.63419	57° 35' 22.9"	— 75.5	1826, April, 15.58512	248° 38' 34.2"	— 1.1
18.62578	56 24 16.6	— 83.2	16.57919	247 21 0.7	0.0
19.62138	55 44 43.5	— 78.5	30.49093	229 16 30.0	+ 16.8
20.61682	55 1 41.9	— 33.4	May 1.48483	228 3 49.4	+ 38.2
21.61218	54 16 45.6	— 53.5	2.47878	226 52 32.8	+ 51.3
22.60734	53 27 38.0	— 14.0	3.47282	225 43 26.5	+ 13.7
29.56852	46 0 15.9	— 135.8	7.44950	221 18 55.7	+ 25.1
Oct. 1.55530	43 7 13.4	— 93.8	8.44387	220 17 26.8	— 17.7
5.52539	36 8 45.7	— 169.1	11.42734	217 20 52.3	— 29.4
6.51713	31 7 23.2	— 222.1	12.42196	216 25 12.6	— 26.2
9.49001	27 15 1.7	— 150.6	13.41670	215 32 15.7	— 86.0
10.48033	24 44 10.0	— 209.0	16.40121	212 59 33.0	— 38.3
12.45985	19 18 36.0	— 138.2	25.35854	206 48 30.0	— 57.1
13.44919	16 27 26.7	— 161.8	26.35110	206 14 5.7	— 37.3
14.43824	13 30 1.0	— 124.7	28.34543	205 9 39.7	— 26.0
15.42710	10 28 48.0	— 121.1	29.34114	204 38 45.4	+ 14.3
1826, April 8.62811	257 14 45.8	+ 85.7	30.33693	204 9 30.5	+ 27.8
13.59786	251 10 15.1	+ 73.6	31.33280	203 42 4.9	+ 2.8
14.59168	249 54 48.7	+ 36.2			

Göttingen. (HARDING.) *Astr. Nachr.*, IV. 220; V. 153, 270.

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta\alpha$	$\Delta\delta$
1825, Aug. 9.49397	63° 39' 45.4"	+23° 52' 34.7"	+10.3	+ 8.1
10.48875	63 42 31.4	23 43 27.8	+ 2.7	+ 23.0
15.49432	63 50 9.2	22 55 19.9	+11.6	— 61.8
23.49387	63 39 21.9	21 13 59.2	+ 3.9	— 26.9
24.49111	63 35 25.9	20 58 1.3	+10.5	+ 36.2
25.53484	63 30 52.1	20 41 34.0	+ 3.7	+ 47.3
26.53172	63 25 35.1	+20 24 28.1	+12.0	+100.5
Oct. 12.44172 ⁽¹⁾	19 19 59.2	—30 59 3.4	—36.0	— 40.0
1826, May 9.42468	219 17 29.5	28 36 59.2	— 5.6	+338.3
25.41479	206 45 30.1	19 44 41.8	+ 5.2	— 45.7
29.38843	204 36 50.8	17 54 29.6	+44.6	— 69.4
30.40836	204 7 55.3	17 28 50.7	+ 0.9	— 16.6
June 8.41009	200 35 48.7	—14 4 20.3	+ 0.7	+ 17.9

⁽¹⁾ δ recorded — 31° 9'.

Greenwich. *Greenwich Astronomical Observations, 1825.**Five-foot Equatorial.*

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta \alpha$	$\Delta \delta$
1825, Aug. 25.63217	63° 30' 6".	+20° 40' 31.3"	+21.4"	+17.0"
Sept. 8.54805	60 57 57.2	15 31 58.7	+66.0	+13.7
11.53435	59 56 28.3	13 53 36.3	+25.9	+21.0
15.52901	58 9 27.7	11 15 19.3	+7.4	—11.6
22.46111	53 34 7.7	+4 56 27.5	+36.2	+10.4
Oct. 3.47889		—11 57 45.5		—11.7
.47915	39 56 18.8		—10.2	
.51796	39 51 21.5	—12 2 52.1	+12.1	+15.8
<i>Meridian Instruments.</i>				
Sept. 17.66111	56 58 20.1	+9 34 29.6	+17.5	—5.8
22.63844	53 25 49.8	+4 44 52.2	+0.1	—5.8

Josephstadt. (BIELA.) *Astr. Nachr.*, Circular to No. 83; V. 269.

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta \alpha$	$\Delta \delta$
1825, July 23.52468	62° 12' 7".	+25° 48' 33.1"	+99.9"	—42.1"
Aug. 9.53356 ⁽¹⁾	63 39 53.5	23 52 47.3	+8.8	—25.4
13.53642	63 47 43.4	23 14 12.4	+44.2	+31.3
14.48617	63 49 15.2	23 5 29.3	+19.1	—29.5
22.55951	63 41 45.5	21 24 35.6	+42.2	+143.1
25.55154	63 30 26.0	20 42 27.8	+25.0	—22.5
Sept. 9.48293	60 41 44.2		+19.5	
21.46988	54 22 24.7	+6 0 14.5	+7.3	+25.6
Oct. 5.50230	36 9 9.5	—16 7 42.0	—27.3	+50.7

Kremsmünster. *Astr. Nachr.*, IV. 479; V. 171.

A simple comparison of the successive discrepancies with the same pairs of stars is sufficient to show that little, if anything, would be gained by the reduction of these observations.

Mannheim. (NICOLAI.) *Astr. Nachr.*, V. 55.

Observations with a four-and-a-half-foot Fraunhofer, using the diaphragm of the eye-piece as a ring-micrometer. Two typographical corrections are given in *Astr. Nachr.*, V. 303.

M. T. Greenwich.	α	δ	C. — O.		No. of Comp.
			$\Delta \alpha$	$\Delta \delta$	
1825, Aug. 12.51768	63° 46' 41.9"	+23° 24' 37.3"	+10.4"	+11.0"	4
17.48074	63 50 52.7	22 32 22.3	—17.4	—19.3	9
18.45296	63 50 2.5	22 20 46.7	+0.3	—13.8	2
20.48339	63 47 24.1	21 55 27.7	+0.8	—20.4	6
21.44018	63 45 27.5	21 42 43.3	—1.7	—17.3	5
22.45004	63 42 35.4	21 28 32.3	+11.7	—1.1	5
23.46158	63 39 30.9	+21 14 1.9	+1.7	—1.2	5
1826, May 1.49150	228 4 0.3	—33 2 42.4	—1.5	+3.2	2
3.47627	225 43 22.2	31 57 18.4	+3.9	+12.8	2
13.41550	215 30 40.6	26 11 49.0	+12.9	+7.3	4
15.44104	213 46 7.9	25 2 6.9	+2.4	+7.2	4
29.40788	204 36 59.4	17 55 15.4	+1.3	+7.1	3
30.39827	204 8 19.8	—17 29 33.8	—6.4	+11.0	4

⁽¹⁾ α recorded 29'.

Munich. (SOLDNER.) *Astr. Beob. auf der k. Sternwarte zu Bogenhausen*, IV. xv.

Meridian Observations.

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta \alpha$	$\Delta \delta$
1825, Oct. 2.51725	41° 30' 50".5	—10° 9' 4".7	— 9.5	+2.4
8.49901	29 37 25.9	—22 35 36.2	—21.1	—5.6

Naples. (CAPOCCI.) *Corr. Astr.*, XIII. 282, 596; XIV. 505.

Equatorial.

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta \alpha$	$\Delta \delta$
1825, Aug. 25.60771	63° 30' 37.9	+20° 40' 51.9	— 3.3	+19.6
26.61378	63 24 58.0	20 24 24.9	+21.8	21.7
27.61581	63 19 6.1	20 7 31.9	17.8	11.5
28.61483	63 12 26.1	19 49 42.0	18.6	16.9
Sept. 2.59353	62 26 57.8	18 8 32.3	+15.0	19.2
6.62217	61 32 29.8	16 27 46.6	—12.5	12.5
7.58086	61 17 7.7	+16 0 12.8	—46.0	+40.9

Meridian Circle.

1825, Sept. 12.64145	59 30 3.0	+13 13 8.3	+ 7.1	+14.3
14.63385	58 36 20.0	11 53 46.6	+ 1.3	+ 4.0
16.62587	57 34 27.0	10 24 56.0	— 2.9	— 0.2
17.62176	57 0 38.0	9 36 25.2	36.0	+ 6.9
19.61308	55 43 57.0	7 50 55.6	—11.5	0.7
21.60389	54 16 8.0	5 52 5.2	+ 7.5	8.6
23.59412	52 36 15.0	+ 3 38 12.8	—17.7	27.0
27.57236	48 29 21.0	— 1 40 11.7	+ 0.9	+ 5.1
Oct. 3.53265	39 50 5.0	12 4 5.0	— 4.2	—16.4
6.50874 ⁽¹⁾	34 5 22.0	18 15 35.6	37.0	3.8
12.45156	19 18 15.0	31 0 46.9	32.4	— 7.8
18.38467 ⁽²⁾	1 10 45.0	40 54 28.2	37.1	+10.2
1826, April 14.58344	249 56 15.0	39 50 49.0	—12.2	24.2
15.57715	248 38 15.0	—39 36 24.0	+56.9	+45.9

Nismes. (VALZ.) *Corr. Astr.*, XIV. 294, 297, 505.

Reducing only those observations for which the comparison-stars had been already determined, I found the following : —

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta \alpha$	$\Delta \delta$
1825, Sept. 2.56307	62° 26' 53".7	+18° 9' 30".9	+ 40.0	+ 2.1
	26 44.2	10 40.3	49.5	— 67.3
Oct. 13.43406	16 26 42.8	—32 59 39.3	+ 42.1	+160.0
14.41777	13 27 6.3	34 51 5.6	— 53.7	42.3
	26 14.6	50 57.8	2.0	34.5
15.45007	10 23 40.2		— 18.4	
17.41815	4 12 30.2		+ 45.8	
1826, April 3.64998	262 53 39.6	41 24 59.4	—335.4	70.4
6.65680	259 31 14.1	41 9 42.1	+ 48.6	23.6
	30 28.8	9 49.6	93.9	31.1
7.64069	258 24 7.3	—41 4 56.2	+ 48.8	+120.4

⁽¹⁾ α recorded 1'.

⁽²⁾ Given mean time and α both 1^m too great.

Padua. (SANTINI.) *Corr. Astr.*, XIII. 591; XIV. 594.

Positions obtained from the circles of an equatorial instrument.

In the original record,

Sept. 2 for 15 28 30 read 15 27 26
 " 63 42 10 " 62 27 10

Sept. 2 for 63 26 57 read 62 26 57
 Oct. 6 " δ Balena " σ Balena
 " γ Eridano " τ' Eridano
 Oct. 11 " 10 19 48 " 10 23 57

Observation of τ' Eridani is discordant, and rejected.

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta\alpha$	$\Delta\delta$
1825, Aug. 21.60125	63° 35' 3.9	+20° 56' 35.1	+ 5.0	+21.3
25.60125	63 30 43.6	20 41 2.2	— 7.2	15.2
26.59773	63 25 21.8	20 24 43.5	+ 3.4	+19.2
Sept. 2.60237	62 27 6.9	+18 8 40.2	— 0.2	— 0.9
Oct. 6.44683	34 12 53.0	—18 7 33.3	—17.4	— 6.4
10.43261	24 48 50.3	26 48 4.7	—10.4	+ 4.9
14.39671	13 35 37.3	34 45 29.0	—10.0	+33.5
1826, May 1.43655	228 8 28.7	33 3 52.5	—31.9	—33.5
2.41667	226 57 39.7	32 32 20.7	+ 8.6	2.0
11.43529	217 20 27.7	—27 20 24.6	—31.8	—22.1
13.41320	215 31 11.9		—11.0	

Palermo. (CACCIATORE.) *Del Real Osservatorio di Palermo*, Libri VII., VIII. e IX.; I. 224.

Observations with the altazimuth, partly extra-meridional, stars in the same part of the heavens, in the other, by a larger and partly with the instrument used as a transit-circle. In the number of stars of various declinations. one case the instrumental corrections are given by one or two

M. T. Greenwich.	Azimuth.	Zen. Dist.	α	δ	$\Delta\alpha$	$\Delta\delta$
1825, Sept. 8.53214	—106° 39' 46.2	45° 51' 8.9	60° 59' 52.3	+15° 32' 43.5	—31.4	— 2.2
11.49150	99 58 52.3	55 10 7.6	59 57 51.1	13 55 15.4	+ 2.5	+13.3
12.49082	101 19 51.8	54 43 21.4	59 35 11.2	13 18 41.2	—75.2	+18.3
13.46742	96 58 38.8	60 36 36.9	59 9 18.3	12 41 10.6	—31.5	+17.3
16.46248	100 38 52.6	59 59 57.1	57 40 29.3	10 31 38.7	—40.5	+57.8
17.44478	97 59 8.0	64 17 7.6	57 6 47.0	9 44 53.2	—28.0	+27.3
20.49201	62 32 4.8	49 45 1.8	55 6 53.7	+ 6 59 49.7	—17.6	+25.4
Oct. 18.34635	11 20 49.9	80 7 52.1	1 7 49.4	—40 51 39.0	—25.9	+15.0
20.36427	— 8 2 2.2	81 48 2.7	355 3 40.4	43 5 9.4	—21.7	+ 8.4
1826, Apr. 3.63019	— 5 32 33.2	79 47 39.5	262 49 23.6	41 24 14.6	— 4.8	+21.3
4.62651	— 5 1 35.0	79 40 50.8	261 46 4.2	—41 20 27.4	— 7.4	+34.8

Meridian Observations.

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta\alpha$	$\Delta\delta$
1825, Sept. 21.60634	51° 16' 9.9	+ 5° 52' 10.5	— 1.3	— 6.0
Oct. 5.51949	36 6 48.9	—16 8 59.2	10.0	— 2.7
7.50251	31 55 4.1	20 25 5.5	11.4	+ 7.8
11.46436	22 3 7.7	28 59 20.5	21.4	5.6
12.45397	19 17 20.2	31 1 16.0	62.2	3.8
13.44335	16 26 58.9	32 58 8.6	72.3	+ 5.1
18.38719	1 11 20.8	40 54 8.6	—101.8	—20.9
1826, April 3.65029	262 47 47.9	41 24 11.8	+ 15.1	+23.0
4.64475	261 45 29.6	—41 20 54.3	— 43.3	+66.5

Paramatta. (DUNLOP.) *Edinburgh Journal of Science*, VI. 93.

Observations with a forty-six-inch Banks Equatorial, and wire-micrometer. One revolution of mic. screw = $58''.051$.
(*Mem. R. Astr. Soc.* III. 258.) Meridian observations from Oct. 18 to 27 inclusive.

July 25, 26, 27.	for α Taurus	read γ Taurus.	Aug. 19,	for 2d ν Taurus	read 1st ν Taurus.
Aug. 7,	" -0 46.00	" + 0 46.00	Oct. 4,	" 0 12 4	" 23 12 4
	" 6 49.32	" 16 49.32	" 10,	" +1 1.0	" -1 1.0

M. T. Greenwich.	α	δ	$\Delta\alpha$	$\Delta\delta$	No. of Comp.
1825, July 21.31223	61° 55' 57".3	+25° 59' 55".1	+130.5	- 51.7	1
22.29297	62 3 57.8	25 59 3.1	+ 72.4	-172.7	2
23.28590	62 11 53.6	25 48 26.1	+ 14.5	+ 39.4	6
25.29570	62 24 40.3	25 38 39.9	+ 62.5	- 17.6	3
26.28162	62 30 49.2	25 32 49.1	+ 77.3	+ 3.9	10
27.30028	62 38 27.2	25 27 1.0	+ 3.9	+ 2.0	3
Aug. 7.30523	63 34 5.2	24 10 3.2	- 65.8	+ 69.6	1
10.22251	63 41 35.8	23 46 4.7	+ 17.9	+ 10.2	11
14.24293 ⁽¹⁾	63 48 42.8	23 1 56.5	+ 36.5	+334.8	9
16.25966	63 49 55.1	22 45 55.7	+ 43.8	- 0.5	13
19.28896	63 48 53.1	22 9 51.7	+ 19.9	+ 27.2	10
Sept. 8.15720	61 5 41.1	15 44 2.5	+ 31.0	- 4.2	10
9.29328	60 44 36.6	15 9 14.2	+ 12.3	- 7.8	2
29.572	45 1.6		- 15.5		1
12.21028	59 10 27.0	13 29 59.2	+ 23.2	- 30.9	13
15.11414	58 22 15.0	11 33 12.9	- 2.9	+ 6.1	15
17.11292	57 17 24.2	10 1 33.3	+ 29.2	+ 3.3	16
19.12613	56 3 0.4	8 17 11.0	+ 23.2	+ 43.7	14
22.09190	53 52 45.4	5 20 50.9	+ 9.7	+ 4.7	22
24.16322	52 3 44.4	+ 2 57 28.0	+ 55.3	+ 0.6	10
Oct. 1.00025	43 56 6.3	- 7 17 5.8	+ 2.0	- 12.7	4
2.05796	42 18 2.5	9 13 22.1	+ 16.1	- 5.1	13
4.00749	38 59 4.8	13 1 18.2	+ 4.8	- 8.7	8
7.01352	32 59 51.4	19 21 17.3	- 8.2	+ 9.2	7
9.07477	*+ 30 41.2	*- 5 5.5			7
10.03381	25 50 20.9	25 56 20.9	- 18.4	- 5.4	7
29.98441	329 31 0.0	47 26 19.1	- 12.9	+ 10.0	6
Nov. 1.06745	325 26 5.1	47 30 38.9	- 26.5	+ 16.2	2
6.99808	316 17 8.3	47 2 50.7	+ 13.7	+ 16.6	4
7.93691	*+ 1 4 22.2	*+15 49.4			4
18.97519	305 27 46.9	45 13 45.3	+ 4.1	+ 20.5	5
19.93460	304 52 56.4	45 4 47.6	- 9.6	+ 8.3	7
20.93728	304 17 56.0	44 55 41.8	+ 5.4	+ 3.6	3
Dec. 8.97184	297 35 29.7	42 41 15.1	- 42.0	+ 10.5	4
11.93762	296 54 31.2	42 23 53.8	- 15.2	+ 3.0	5
15.92127	296 6 20.6	42 2 41.4	+ 13.7	+ 3.9	3
19.94213	295 24 49.1	-41 43 23.9	- 3.9	+ 7.9	6
23.93865	*-2 34 38.2	*- 9 5.4			3
Meridian.					
1825, Oct. 18.00914	2 22 32.7	-40 21 51.3	- 71.7	- 27.7	
19.98628	356 8 55.5	42 43 53.1	- 41.6	- 11.5	
24.93187	341 37 8.6	46 14 57.0	- 33.5	+ 6.6	
26.91200	336 30 10.5	46 55 59.1	- 25.1	+ 9.8	
27.90256	334 7 34.8	-47 9 59.0	- 33.2	+ 32.8	

Paris. (Meridian Observation.)

M. T. Greenwich.	α	δ	$\Delta\alpha$	$\Delta\delta$	C - O.
1825, Sept. 19.64597	55° 42' 27".4	+7° 49' 27".6	- 2.9	-22.3	

⁽¹⁾ Error of 5 or 6 rev. = $290''.3$ or $348''.3$?

Prague. (DAVID.) *Astr. Nachr.* IV. 373.

These observations, uncorrected for parallax, give the following residuals:—

M. T. Greenwich.	$\Delta\alpha$	$\Delta\delta$	M. T. Greenwich.	$\Delta\alpha$	$\Delta\delta$	M. T. Greenwich.	$\Delta\alpha$	$\Delta\delta$
1825, Aug. 12	+14"	+144"	1825, Aug. 25	+35"	— 19"	1825, Sept. 20	— 2"	— 41"
13	56	68	26	—10	83	21	+33	88
15	41	90	31	+ 8	60	30	—11	168
18	63	108	Sept. 1	38	49	Oct. 1	+19	— 30
19	19	96	9	39	71	2	—13	+ 94
20	67	57	10	27	87	3	+22	45
22	0	95	11	18	70	4	+ 4	72
23	69	+ 35	12	13	130	5	—16	+104
24	+37	— 10	19	+11	— 69			

Prague. (HALLASCHKA.) *Astr. Nachr.* IV. 361. *Astr. Jahrbuch*, 1829, 101.

M. T. Greenwich.	α	δ	C. — O.	
			$\Delta\alpha$	$\Delta\delta$
1825, Sept. 11.53452	59° 56' 48.9"	+13° 53' 9.5"	+ 5.2	+ 47.5
12.57996	59 32 10.8	13 17 5.0	— 28.2	— 83.3
13.13935	59 10 0.5	12 43 31.2	28.6	— 56.7
19.38541	55 53 41.3	8 4 31.3	— 40.0	— 52.5
21.36729	54 25 22.0	+ 6 6 12.0	+116.0	+ 53.1
Oct. 1.38073	43 22 15.5	— 7 57 47.8	— 31.2	— 38.8
2.36597	41 48 58.9	9 18 56.8	28.5	+ 38.3
4.37120	38 20 22.3	13 45 26.9	73.5	— 21.2
5.36003	36 26 35.2	15 50 38.5	58.1	+105.9
6.35556	34 24 24.9	17 55 20.7	— 18.7	— 32.7
8.37290	29 54 22.7	22 18 11.3	+ 33.6	— 26.5
9.36661	27 31 22.2	—24 29 26.8	— 26.6	— 2.5

Seeberg. (HANSEN.) *Ausführliche Methode . . . nebst Cometen-beobachtungen . . .*

Observations with a three-and-a-half-foot Fraunhofer heliometer. I have reduced them anew with the utmost care, following the precepts given in the first part of the work referred to.

M. T. Greenwich.	α	δ	$\Delta\alpha$	$\Delta\delta$	No. of Comp.
1825, Sept. 12.49904	59° 33' 47.7"	+13° 18' 35.7"	— 4.0	+ 8.4	5
13.45622	59 9 2.4	12 41 53.9	+ 2.6	+ 0.6	5
17.49983	57 4 21.6	9 42 36.9	+ 0.6	— 0.2	4
18.40809	56 31 8.2	8 56 14.3	+ 1.6	+ 3.6	6
20.42136	55 9 42.0	7 4 22.5	— 1.6	+ 3.0	7
25.45506	50 49 0.3	+ 1 18 48.4	— 4.8	— 6.8	2
29.43358	46 9 6.2	— 4 35 31.1	—12.7	—11.4	5
30.48686	44 41 23.6	6 22 48.7	—12.3	— 9.3	5
Oct. 1.48856	43 11 56.6	8 10 36.8	— 7.0	+ 7.7	6
2.48635	41 36 47.6	10 2 0.7	— 6.0	— 2.7	6
4.49338	38 5 29.3	14 0 48.3	+ 0.5	— 0.6	4
5.47255	36 12 19.2	16 3 2.4	— 4.1	— 3.1	4
6.49460	34 6 41.5	18 3 39.8	— 8.9	—10.0	4
1826, Apr. 29.51204	230 28 56.5	34 4 50.7	+12.3	—37.0	3
May 8.45741	230 16 7.0	29 5 28.8	+12.0	+10.8	3
9.42125	219 17 52.5	28 31 4.7	—16.2	—23.5	3
10.42902	218 18 6.1	27 55 56.8	—13.8	— 7.4	4
11.41888	217 20 59.0	27 21 18.6	— 7.2	— 2.1	3
14.46492	214 35 29.0	—25 35 14.3	+18.0	—11.8	4

(To be continued.)

OBSERVATIONS OF THE FIRST COMET OF 1859.*

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — Corrected for refraction.]

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$\Delta\alpha$	$\Delta\delta$	α	δ
	^h ^m ^s			^m ^s		^h ^m ^s	[°] ['] ["]
1859, Apr. 29	8 35 9.4	3	A. Z. 76, 107	+1 24.88	+ 8 57.97	6 26 21.08	+50° 8' 28.62
	9 44 11.9	10	" 76, 107	+1 13.29	+ 3 36.60	6 26 9.49	50 3 5.42
30	8 31 33.3	6	" 177, 13	-2 14.58	+14 54.17	6 22 19.78	48 18 15.69
		6	" 177, 14	-3 57.99	+ 5 11.99	6 22 19.61	48 18 16.64
May 1	8 32 44.6	15	" 172, 86	+0 19.47	+ 2 10.84	6 18 34.92	46 28 25.49
	8 26 20.0	12	" 172, 87	-0 57.69	-17 30.84	6 18 34.24	46 28 56.40
2	8 51 48.9	10	B. Z. 511, 63	+2 55.85	+ 9 24.71	6 14 57.36	44 37 51.53
		10	" 511, 71	-0 57.93	+ 9 38.21	6 14 57.47	44 37 56.18
4	8 32 17.7	10	" 522, 159	+1 2.40	+ 8 25.77	6 8 30.21	41 4 24.54
5	9 6 4.1	5	Anon.			6 5.3	39 16.8
7	8 26 21.8	5	Lalande 11513	+1 32.58	-24 52.71	5 59 27.61	35 52 21.65
	8 35 1.1	10	" 11528	+1 0.20	-13 15.49	5 59 26.21	35 51 32.92
8	8 27 54.1	10	B. Z. 518, 90	+1 53.07	-11 47.15	5 56 25.22	+34 10 46.34

This Comet was discovered by Mr. FERGUSON at Washington on the evening of the 28th, but clouds prevented any accurate determination of its place.

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
A. Z. 76, 107	9	6 24 59.68	+49° 59' 11.96	} Argelander's Zones.
" 177, 13	8.5	6 24 37.76	48 3 5.31	
" 177, 14	8.5	6 26 20.99	48 12 48.22	
" 172, 86	8	6 18 18.85	46 25 59.44	
" 172, 87	6	6 19 35.34	46 46 11.83	
B. Z. 511, 63	8	6 12 4.89	44 28 12.75	} Bessel's Zones.
" 511, 71	9	6 15 58.85	44 28 3.50	
" 522, 159	8	6 7 26.87	40 55 46.79	
Anon.	8	6 8.0	39 31.4	} Lalande's Catalogue.
Lalande 11513	6.5	5 57 58.25	36 17 3.94	
" 11528	6.5	5 58 29.22	36 4 37.98	
B. Z. 518, 90	8	5 54 45.32	+34 22 23.81	Bessel's Zones.

* This Comet was first detected April 2, by Mr. TEMPEL, at Venice, on which day its position, approximately determined by Harding's Atlas, was, — April 2 8^h 15^m, $\alpha = 14^h 30^m$, $\delta = 71^\circ$. It was first observed at Padua April 7, Vienna April 10, Berlin April 14. G.

NOTICE.

No. 121 of this Journal was published at Albany, 1859, January 6, — three days after the violent ejection of the Editor, with his corps of assistants, from the Dudley Observatory by a gang of men hired for the purpose. Besides its regular astronomical contents, that number contained a supplement with the Editor's Address to the Friends of the Observatory, in which the facts of the case were briefly recounted.

Complaints of the non-reception of this number have been received from all quarters, and have led to the discovery, that by some means, — unsuspected at the time, but quite intelligible now, — the entire edition was intercepted, with the exception of a few copies forwarded through Messrs. Westermann. Steps have been taken to reissue this number which will, it is hoped, speedily follow the present one.

The Editor begs that this notice may be accepted as a sufficient response to letters addressed him upon the subject. G.

Cambridge, 1859, May 20.

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OBSERVATIONS OF THE FIRST COMET OF 1859, BY MR. JAMES FERGUSON.

THE ASTRONOMICAL JOURNAL.

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CAMBRIDGE, 1859, JUNE 14.

NO. 5.

ON THE ORBIT OF THE FOURTH COMET OF 1825.

BY PROFESSOR J. S. HUBBARD.

(Concluded from page 31.)

Spire. (SCHWERD.) *Astr. Nachr.*, IV. 291, 344. *Astron. Beob.*.... in Speyer, 1826, 107.

Ring-Micrometer observations with a three-and-a-half-foot Fraunhofer telescope.

M. T. Greenwich.	α	δ	C. — O.		No. of Comp.
			$\Delta \alpha$	$\Delta \delta$	
1825, Aug. 12.52157	63° 46' 14.0"	+23° 24' 36.3"	+38.8"	+ 9.8"	2
22.55494	63 42 11.1	21 27 7.8	+17.5	— 5.1	8
23.53356	63 39 11.0	21 12 49.1	+ 6.3	+ 8.3	7
25.53990	63 30 29.2	20 42 20.4	+25.2	— 3.9	5
Sept. 9.60398	60 38 38.9	+14 59 6.2	— 0.6	+ 6.4	6
Oct. 5.44219	36 16 7.0	—15 59 27.8	—14.9	+12.6	11
8.45352	29 43 51.2	22 29 34.5	—19.1	— 8.6	
1826, May 2.48793	226 52 43.0	32 30 6.0	+ 2.3	+ 4.5	4
9.45354	219 15 15.2	28 30 27.3	+24.6	+ 7.2	6
11.42175	217 20 36.6	27 21 13.4	+ 5.4	— 1.2	3
30.40021	204 7 49.1	—17 29 3.8	+21.0	—16.0	5

Stargard. (RÜMKE.) *Philosophical Transactions*, 1829, Part III. p. 61.

Observations with a ring-micrometer, and made, as I am informed, under peculiarly unfavorable circumstances;—the telescope being very unsteadily mounted, and the pocket-chronometer held in the hand. This will account for many discrepancies in this otherwise so valuable series. The differences of the subjoined places and residuals from those given by HANSEN in No. 104 of the *Astronomische Nachrichten*, arise from the circumstance that in the latter the places of the comparison-stars were taken from LACAILLE, while the present places depend on RÜMKE's special determinations of the stars.

M. T. Greenwich.	α	δ	C. — O.		No. of Comp.	
			$\Delta \alpha$	$\Delta \delta$	α	δ
1825, Oct. 13.92484		—33° 52' 21.8"		— 23.6"		4
.92863	15° 0' 7.0"		— 26.2"		5	
14.93565	11 57 56.4	35 42 18.4	38.7	— 2.9	2	1
16.90346	5 50 43.2		10.2		3	
18.22599	1 41 0.5	40 43 31.7	48.8	+ 79.4	5	4
19.25108	358 27 19.6	41 55 45.3	60.8	— 41.8	2	2
19.89993	356 25 17.8	42 38 22.2	54.5	21.1	8	8
21.23934	352 16 27.4	43 54 23.1	6.4	23.2	9	9
22.25632	349 14 9.3	44 42 1.5	87.6	55.1	1	1
23.22108	346 23 53.6	45 20 6.9	37.0	— 65.8	4	4
25.09202	341 11 34.1	46 19 15.2	50.1	+ 20.0	8	8
25.89913	339 3 57.1	46 36 56.5	46.0	— 24.5	6	6
26.89527	336 32 15.4	46 59 54.4	1.7	+261.0	1	1
28.12978	333 36 22.8	47 13 7.8	64.1	+ 67.8	14	14
29.14170	331 20 34.0	47 20 35.2	108.7	— 32.3	8	8
29.97341	329 32 57.1	—47 24 25.7	— 47.6	—100.3	8	8

M. T. Greenwich.		α	δ	C. — O.		No. of Comp.	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1825, Nov.	12.94251	309° 58' 35".3	—46° 10' 2".6	— 56".4	— 7".6	7	7
	13.92391	309 7 23.8	46 1 8.1	17.8	+ 15.6	7	7
	15.92691	307 32 51.1	45 41 33.5	— 19.0	— 19.2	3	3
	19.93707	304 52 33.2	45 4 24.5	+ 8.4	— 13.7	5	5
	21.91670	303 45 47.2		+ 1.9		5	
	24.92140	302 17 45.5	44 21 34.6	— 65.0	+ 16.3	2	2
	29.92562	300 15 59.6	43 38 57.1	— 66.1	—176.9	1	1
	30.91518	299 53 40.9	43 36 28.8	+ 23.0	+112.5	4	4
Dec.	2.93371	299 12 30.4	43 19 37.4	+114.4	— 36.1	1	1
	8.94633	297 35 45.2	42 40 33.2	— 35.3	— 40.6	8	5
	11.93932	296 54 56.1	42 24 12.1	41.3	+ 21.9	4	4
	15.91813	296 7 44.9	42 2 8.7	68.5	— 29.7	1	1
	19.92896	295 25 47.5	—41 43 56.7	— 54.6	+ 37.0	5	5

St. Croix. (LANG.) *Astr. Nachr.*, IV. 449; V. 287.

Observations with a small altazimuth; on two occasions with the instrument placed in the meridian.

M. T. Greenwich.		Azimuth.	Zen. Dist.	ΔA	ΔZ
1825, Oct.	9.54125	—54° 14' 4".0	70° 12' 22".3	+ 47".9	— 70".7
Dec.	6.44761	+38 42 30.0	80 15 27.7	— 13.0	+159.9
	10.45115	41 38 44.0	83 56 6.1	— 50.3	+212.0
	11.43836	40 25 30.0	81 47 2.2	—152.3	+185.2
	14.43801	42 0 0.0	83 53 51.2	+ 73.8	+100.2
	44633	+43 8 40.0	85 52 44.3	— 62.6	— 51.7
		α	δ	$\Delta\alpha$	$\Delta\delta$
Oct.	19.58995	357 21 19.5	—42 19 20.8	+ 72.2	+ 22.1
Nov.	2.45485	322 59 16.5	—47 28 12.5	— 35.6	+ 8.0

Turin. (PLANA.) *Corr. Astr.*, XIII. 281; XIV. 95, 506.

The places here given were obtained from the circles of an the field being measured with a ring-micrometer. The observations corrected only for aberration give the following residuals.

M. T. Greenwich.	$\Delta\alpha$	$\Delta\delta$	M. T. Greenwich.	$\Delta\alpha$	$\Delta\delta$	M. T. Greenwich.	$\Delta\alpha$	$\Delta\delta$
1825, Aug. 22	—16"	+169"	1825, Sept. 6	0"	+131"	1825, Sept. 17	— 29"	+ 13"
24	4	— 19	7	0	— 14	Oct. 6	24	—1216
25	— 8	— 24	15	—36	— 76	8	— 32	12
26	+16	+128	16	—54	+132	1826, Apr. 14	+208	— 72
Sept. 5	—10	+ 46						

Vienna. (GRINZENBERGER.) *Annalen der k. k. Sternwarte in Wien*. Sechster Theil.

Observations with a three-and-a-half-foot Dollond and Fraunhofer ring. I have reduced them anew with great care.

M. T. Greenwich.		α	δ	$\Delta\alpha$	$\Delta\delta$	No. of Comp.	
						α	δ
1825, Aug.	18.48148	63° 49' 51".3	+22° 20' 14".0	+10".4	— 1".8	5	3
	19.53552	63 48 38.5	22 7 8.2	15.7	+ 6.1	3	2
	21.48613	63 44 55.3	21 41 44.3	24.0	+ 4.4	10	4
	22.54959	63 42 9.7	21 26 43.1	19.9	+24.1	1	1
	23.49260	63 39 23.3	21 13 53.4	2.8	—20.0	4	4
	24.48329	63 35 20.2	20 58 25.1	18.2	+19.6	2	4
	25.54334	63 30 35.0	+20 41 57.5	+18.3	+15.7	3	2

Zehmen. (SCHMIDEL.) *Astr. Nachr.*, IV. 395.

Observations with a transit-instrument.

M. T. Greenwich.	α	$\Delta\alpha$
1825, Oct. 6.51374	34° 3' 2.9"	+61.0
S.49610	29 37 30.0	— 0.3

4.

It is evidently impracticable in this, if not in every discussion of observations, to assign to each individual its true weight relatively to the rest, since one main source of difference is to be found in atmospheric or other local causes, of which no account can now be taken. The next best thing is to arrange, as I have done, the whole series into groups according to observers, that is, according to instrumental means and the success in using them, and to determine for each group its mean error and relative weight; the latter depending not only upon the former, but also upon the chronological location of the observations in the series. And it is again obvious, that for some groups this relative weight would be negative, or detrimental, and that therefore a selection must be made, which, if not arbitrary, would require an expenditure of time

and labor scarcely proportioned to the resulting gain. I believe that the following list includes all observations which could contribute materially to the accuracy of the final result. In computing the mean errors it was necessary first to eliminate, approximately at least, the effect of the error of elements, and this I accomplished by projecting the residuals, chronologically arranged, upon a chart of squares, and drawing curves among the points thus laid down, considering the deviations of the separate residuals from the curve as pure errors of observation. The adopted weights for 1825 are doubtless nearer the truth than those deducible from the mean errors alone. For 1826, when the comet appeared faint and diffuse, and almost equally difficult for every one to observe, I have given equal weights to all the places.

Observations.		1825.						1826.			
		α			δ			α		δ	
		No. of Obs.	Mean Error.	Adopted Weight.	No. of Obs.	Mean Error.	Adopted Weight.	No. of Obs.	Adopted Weight.	No. of Obs.	Adopted Weight.
Åbo,	Ring-mic.	15	11.9	0.75	15	11.9	0.75				
	Heliom.	2		2.00	2		1.50				
Altona,	Ring-mic.	5	11.6	0.75	5	13.9	0.50	4	0.5	4	0.5
	Merid.	5	11.7	0.75	5	9.5	1.00				
Florence,	Ring-mic.	45	12.0	0.75	26	19.0	0.50	31	0.5	12	0.5
Göttingen,	Ring-mic.	8	9.9	1.00				5	0.5		
Greenwich,	Merid.	2		0.75	2		1.00				
Mannheim,	Ring-mic.	7	7.4	1.00	7	10.7	1.00	6	0.5	6	0.5
Munich,	Merid.	2		0.75	2		1.00				
Naples,	Equatorial.	7	16.0	0.50	7	14.7	0.50	2	0.5	2	0.5
	Merid.	12	15.1	0.50	12	11.7	0.75				
Padua,	Equatorial.	7	9.1	1.00	7	15.2	0.50	4	0.5	3	0.5
Palermo,	Merid.	6	24.9	0.25	7	11.7	0.75	2	0.5	2	0.5
	Altazimuth.							2	0.5	2	0.5
Paramatta,	Filar-mic.	35	23.0	0.50	37	22.2	0.50				
Paris,	Merid.	1		0.75	1		1.00				
Seeberg,	Heliom.	13	4.9	2.00	13	8.1	1.50	6	0.5	6	0.5
Spire,	Ring-mic.	7	16.1	0.50	7	13.5	0.50	4	0.5	4	0.5
Stargard,	Ring-mic.	26	27.5	0.25	20	27.0	0.25				
Vienna,	Ring-mic.	7	15.8	0.50	7	19.4	0.25				

We are thus led to the following normals, which may be considered as fully representing the observed path of the comet:—

M. T. Greenwich.	α	No. of Obs.	Weight.	C. — O.	δ	No. of Obs.	Weight.	C. — O.
1825, July 24.0	62° 16' 0.8"	5	2.75	+61.7	+25° 45' 17.7"	6	3.00	+ 3.4
Aug. 9.0	63 38 13.0	9	7.00	+16.8	23 56 40.1	7	4.00	+20.3
17.0	63 50 38.8	17	12.50	+ 2.8	22 37 42.1	15	9.00	— 7.0
25.0	63 33 22.2	31	22.75	+ 2.7	20 50 35.6	23	12.75	+11.1
Sept. 10.0	60 30 37.0	25	21.75	— 3.6	14 46 14.3	23	17.25	+ 7.3
18.0	56 46 23.2	22	17.75	— 2.6	+ 9 17 20.3	21	16.25	+ 4.4

M. T. Greenwich.	α	No. of Obs.	Weight.	C. — O.	δ	No. of Obs.	Weight.	C. — O.
1825, Sept. 26.0	50° 15' 6.0	20	19.25	—11.2	+ 0° 31' 40.6	16	13.50	+ 3.2
Oct. 4.0	39 0 4.1	16	14.25	5.7	—13 0 32.1	15	13.50	— 0.3
8.0	30 47 18.8	11	8.50	16.7	21 30 6.0	10	7.50	— 3.8
12.0	20 34 35.6	11	6.75	35.4	30 5 50.3	6	4.00	+ 1.2
16.0	8 40 46.4	8	3.70	31.5	37 29 15.1	6	3.00	— 3.9
24.0	344 11 4.5	11	3.50	38.9	45 47 50.7	10	3.25	—15.5
Nov. 1.0	325 33 29.6	6	2.50	22.9	47 30 42.5	6	2.50	+18.6
21.0	304 16 11.0	10	3.25	16.4	44 55 9.9	8	2.75	5.1
Dec. 11.0	297 6 55.2	9	3.25	—20.9	42 29 9.7	9	3.25	0.2
1826, Apr. 10.0	255 38 15.8	10	5.00	+13.1	40 41 39.7	8	4.00	+42.6
30.0	229 52 59.1	8	4.00	— 3.0	33 50 7.6	7	3.50	— 7.4
May 12.0	216 48 12.1	22	11.00	— 2.4	27 1 1.1	17	8.50	+ 0.8
June 1.0	203 24 4.0	16	8.00	+ 2.9	16 49 1.9	9	4.50	— 3.0
29.0	196 36 57.4	14	7.00	—16.6	— 9 1 34.9	2	1.00	—16.1

5.

I next computed, with eight-day intervals, the perturbations of the rectangular ecliptic coördinates produced during the period of visibility by *Venus, Earth, Mars, Jupiter, and Saturn*. The planetary places were taken from the Tables of LINDENAU, HANSEN, and BOUVARD, respectively, valuable controls against constant errors being found for occasional dates in the pages of AIRY'S "Reductions," &c. The resulting perturbations for

the dates of the normals, and transformed into equatorial values, are given, in units of the seventh place of decimals, in the subjoined table, under the headings δx , δy , δz ; the quantities dx , dy , dz are the reductions of the coördinates from mean to apparent values; the sums therefore, Δx , Δy , Δz , give the reductions of the same coördinates from mean elliptic to apparent instantaneous values.

M. T. Greenwich.	δx	dx	Δx	δy	dy	Δy	δz	dz	Δz
1825, July 24	+165	+ 85	+ 250	—271	— 6	— 277	—55	— 156	— 211
Aug. 9	150	— 80	70	210	+ 142	— 68	37	63	100
17	141	138	+ 3	181	207	+ 26	30	— 17	47
25	130	177	— 47	155	264	109	23	+ 20	— 3
Sept. 10	107	211	104	107	358	251	13	81	+ 68
18	94	208	114	86	395	309	9	108	99
26	82	196	114	68	428	360	7	130	123
Oct. 4	69	171	102	52	456	404	5	154	149
8	62	157	95	45	469	424	4	164	160
12	56	141	85	39	482	443	3	173	170
16	50	120	70	33	493	460	3	182	179
24	38	72	— 34	28	512	484	2	202	200
Nov. 1	27	— 12	+ 15	15	526	511	0	223	223
21	7	+ 204	211	3	521	518	0	276	276
Dec. 11	0	513	513	— 1	+ 437	+ 436	0	+ 308	+ 308
1826, Apr. 10	186	2607	2793	+ 34	—1895	—1861	52	— 502	— 554
30	241	2885	3126	74	2490	2416	60	701	761
May 12	278	3066	3344	106	2883	2777	63	838	901
June 1	345	3392	3737	177	3607	3430	61	1096	1157
29	+449	+3876	+4325	+322	—4739	—4417	—43	—1544	—1587

Correcting now the computed places of the comet for perturbation our residuals become as follows:—

System 1.

M. T. Greenwich.	$\Delta \alpha$	$\Delta \delta$	M. T. Greenwich.	$\Delta \alpha$	$\Delta \delta$	M. T. Greenwich.	$\Delta \alpha$	$\Delta \delta$
1825, July 24	+59.4	+ 3.6	1825, Oct. 4	— 8.3	— 0.6	1825, Dec. 11	—20.9	+ 0.2
Aug. 9	+14.6	+20.4	8	—19.2	— 3.6	1826, Apr. 10	+15.3	+41.3
17	+ 0.6	— 6.9	15	—37.6	+ 1.8	30	— 0.6	— 9.9
25	+ 0.4	+11.2	16	—33.1	— 3.1	May 12	— 1.1	— 1.8
Sept. 10	— 6.0	+ 7.3	24	—39.5	—14.7	June 1	+ 2.6	— 4.9
18	— 5.1	+ 4.3	Nov. 1	—22.8	+19.1	29	—18.0	—17.1
26	—13.8	+ 3.0	21	—16.3	+ 5.2			

6.

The equations which connect the variations of the comet's in the present case, remarkably well adapted for an accurate geocentric place with those of the elements of its orbit are, determination of the orbit. Giving them the form

$$0 = n + a.1000 \Delta T + b. \Delta \Omega_0 + c. \Delta \omega_0 + d. 0.1 \Delta i_0 + e. 100000 \Delta q + f. 10000 \Delta e,$$

I multiplied them each by one fifth of its weight given above, and then obtained by their solution:—

Resulting Elements.

M. T. Greenwich. M. Equinox 1825, Dec. 11.0.

$$\Delta T = + 0^{\text{d}}.0029805$$

$$\Delta \Omega_0 = + 9.803$$

$$\Delta \omega_0 = + 9.822$$

$$\Delta i_0 = -11.447$$

$$\Delta q = -0.00000269$$

$$\Delta e = +0.00005947$$

$$T \text{ 1825, Dec. 10.684850}$$

$$\Omega \text{ 215}^{\circ} 43' 21.81$$

$$\omega \text{ 256 } 56 \text{ 43.06}$$

$$i \text{ 146 } 27 \text{ 7.48}$$

$$q \text{ 1.2408462}$$

$$e \text{ 0.9954285}$$

$$\Omega_0 \text{ 203}^{\circ} 27' 47.12$$

$$\omega_0 \text{ 240 } 16 \text{ 33.37}$$

$$i_0 \text{ 125 } 51 \text{ 58.01}$$

The substitution of these corrections in the equations of condition gave the residuals shown below under the heading System II. The results of another solution undertaken in order

to ascertain if the larger residuals could be reduced by allowing equal weight to all the equations, are given under System III.

M. T. Greenwich.	System II.				System III.	
	$p \Delta \alpha$	$p \Delta \delta$	$\Delta \alpha$	$\Delta \delta$	$\Delta \alpha$	$\Delta \delta$
1825, July 24	+31.4	+ 0.8	+57.1	+ 1.3	+50.5	— 0.1
Aug. 9	+16.3	+13.9	+11.6	+17.4	+ 4.6	+15.9
17	— 1.0	—18.6	— 0.4	—10.3	— 7.3	—11.8
25	0.0	+18.9	0.0	+ 7.3	— 7.1	+ 5.8
Sept. 10	—16.6	+ 8.8	— 3.8	+ 2.6	—11.3	+ 0.4
18	— 1.1	— 1.4	— 0.3	— 0.4	— 7.9	— 2.7
26	—16.9	— 1.5	— 4.4	— 0.6	—11.6	— 2.4
Oct. 4	+27.0	— 2.0	+ 9.5	— 0.7	+ 3.8	— 0.6
8	+ 7.3	— 3.0	+ 4.3	— 2.0	+ 0.4	— 0.1
12	—10.6	+ 2.9	— 7.9	+ 3.6	— 9.0	+ 6.8
16	+ 1.2	— 2.0	+ 1.6	— 3.3	+ 4.0	+ 1.1
24	— 3.4	—14.4	— 4.9	—22.2	+ 2.9	—19.1
Nov. 1	+ 1.3	+ 4.1	+ 2.6	+ 8.2	+11.3	+ 8.5
21	— 3.7	— 2.9	— 5.7	— 5.3	— 0.4	— 7.0
Dec. 11	— 9.8	— 5.0	—15.2	— 7.7	—11.8	—10.1
1826, Apr. 10	+12.5	+32.5	+12.5	+40.6	+ 7.9	+36.9
30	— 0.9	— 5.6	— 1.1	— 8.1	— 7.0	—10.5
May 12	+ 1.0	+ 0.8	+ 0.4	+ 0.5	— 4.7	— 1.2
June 1	+10.1	— 2.5	+ 6.3	— 2.8	+ 2.8	— 3.8
29	—18.7	— 3.0	—13.4	—15.0	—15.3	—16.0
	$(nn. 6) = 5807''.60$				$(nn. 6) = 6584''.67$	
	$(vv) = 5811''.60$				$(vv) = 6582''.70$	

The two largest residuals, which in the first case contribute more than one third, and in the second more than one half, of the whole sum of squares, are those corresponding to the first right-ascension in 1825, and the first declination in 1826. The former rests upon six observations, — five made at Paramatta and one at Florence; the latter, upon eight well-agreeing observations, of which six were made at Florence and two at Naples. Their farther reduction in magnitude being evidently impracticable with the present equations, — and inasmuch as the introduction of any new element sufficient to reduce them sensibly must destroy the satisfactory representation of

other places, — we must infer the accidentalness of combination of sign and magnitude in the separate observations from which these two normals are formed.

The first system of residuals is evidently to be preferred, and may be considered as a satisfactory representation of the observations. Perhaps even the slight traces of irregularity — insufficient in themselves to incite inquiry — might be entirely removed by another solution of the equations, excluding those furnished by the above-mentioned two residuals. I have thought best, however, to rest content with the results before us, as based upon all the normals.

OBSERVATION OF THE MAXIMUM OF OMICRON CETI.

By STILLMAN MASTERMAN.

Maximum + 118, from Epoch of Argelander's Formula of Sines.

Date. Wash. M. T.		Comparison.									
		70 Ceti.	63 Ceti.	69 Ceti.	38 Arietis.	ν Ceti.	λ Ceti.	94 Ceti.	α Ceti.	ξ Piscium.	
1858, Oct.	5.46	$\circ = 70$	$\circ 2\ 63$	$69\ 2\ \circ$							
	6.52	$\circ 2\ 70$	$\circ 3\ 63$	$69 = \circ$							
	8.52				$\circ 2\ 38$	$\nu = \circ$	$\lambda\ 3\ \circ$	$\circ 3\ 94$	$\alpha\ 1\ \circ$		
	9.50	ν Piscium.	δ Ceti.	μ Ceti.	$\circ 4\ 38$	$\circ 3\ \nu$	$\lambda = \circ$		$\circ 3\ \alpha$		
	10.59	$\nu\ 3\ \circ$			ξ^2 Ceti.		$\circ 4\ \lambda$	$\circ$ Piscium.		$\circ 3\ \xi$	
	11.55	$\nu\ 1\ \circ$	$\delta\ 2\ \circ$	$\circ = \mu$	$\xi^2\ 2\ \circ$			$\circ P.\ 3\ \circ$	α Piscium.		
	14.45	$\circ 4\ \nu$	$\circ 2\ \delta$		$\circ 3\ \xi^2$	γ Ceti.	η Piscium.	$\circ 2\ \circ P.$	$\alpha\ 4\ \circ$	ϵ Eridani.	
	15.55		$\circ 5\ \delta$			$\gamma\ 3\ \circ$	$\eta\ 2\ \circ$	δ Eridani.	$\circ 1\ \alpha$	$\circ = \epsilon$	
	18.40	α Trianguli.		β Trianguli.	β Arietis.	$\gamma\ 2\ \circ$		$\circ 3\ \delta$	$\circ 2\ \alpha$	$\circ 1\ \epsilon$	
	25.55	$\circ 3\ \alpha$	ξ Persei.	$\beta\ 2\ \circ$		$\circ 2\ \gamma$	$\circ 4\ \eta$	$\circ 4\ \delta$			
	26.46	$\circ 3\ \alpha$		$\beta\ 1\ \circ$	$\beta\ 5\ \circ$	$\circ 3\ \gamma$				ϵ Persei.	
	27.40	$\circ 4\ \alpha$		$\beta\ 1\ \circ$	$\beta\ 5\ \circ$	$\circ 3\ \gamma$					
	28.40	$\circ 4\ \alpha$		$\circ = \beta$	$\beta\ 4\ \circ$	$\circ 3\ \gamma$	$\circ 4\ \eta$	γ Eridani.	δ Andromedae.	$\epsilon = \circ$	
	Nov.	1.50		$\xi = \circ$	$\circ 1\ \beta$	$\beta\ 2\ \circ$			$\gamma\ 1\ \circ$	$\circ 2\ \delta$	$\circ 1\ \epsilon$
		2.50		$\circ 1\ \xi$	$\circ 2\ \beta$	$\beta\ 2\ \circ$			$\gamma\ 1\ \circ$		$\circ 1\ \epsilon$
		8.42		$\circ 2\ \xi$							
		11.46		$\circ 2\ \xi$	$\circ 2\ \beta$	$\beta\ 1\ \circ$			$\gamma\ 1\ \circ$	$\circ 2\ \delta$	$\circ 2\ \epsilon$
		12.37		$\circ 1\ \xi$	$\circ 2\ \beta$	$\beta\ 2\ \circ$			$\gamma\ 2\ \circ$	$\circ 2\ \delta$	$\circ 2\ \epsilon$
		14.52		$\circ 1\ \xi$	$\circ 2\ \beta$	$\beta\ 2\ \circ$				$\circ 2\ \delta$	
		15.33		$\circ = \xi$	$\circ 1\ \beta$	$\beta\ 3\ \circ$	$\circ 4\ \gamma$				$\circ 1\ \epsilon$
21.38			$\xi\ 1\ \circ$	$\beta\ 1\ \circ$	$\beta\ 5\ \circ$	$\circ 3\ \gamma$	$\circ 3\ \eta$	α Piscium.	$\delta = \circ$	$\circ = \epsilon$	
22.33		$\circ 4\ \alpha$	$\xi\ 1\ \circ$	$\beta\ 1\ \circ$		$\circ 3\ \gamma$	$\circ 3\ \eta$		$\delta = \circ$	$\epsilon\ 1\ \circ$	
29.38		$\circ 3\ \alpha$	$\xi\ 3\ \circ$	$\beta\ 3\ \circ$		$\circ 2\ \gamma$	$\circ 1\ \eta$	$\circ 5\ \alpha$	$\delta\ 2\ \circ$	$\epsilon\ 2\ \circ$	
Dec.	30.33	$\circ 3\ \alpha$	$\xi\ 4\ \circ$	$\beta\ 3\ \circ$		$\circ 2\ \gamma$	$\circ = \eta$	$\circ 5\ \alpha$	$\delta\ 2\ \circ$	$\epsilon\ 2\ \circ$	
	1.33	$\circ 2\ \alpha$	$\xi\ 4\ \circ$	$\beta\ 4\ \circ$	δ Ceti.	$\circ 1\ \gamma$	$\circ = \eta$	$\circ 4\ \alpha$	$\delta\ 3\ \circ$	$\epsilon\ 3\ \circ$	
	6.33	$\circ 1\ \alpha$	$\xi\ 5\ \circ$	$\beta\ 4\ \circ$		$\gamma = \circ$		$\circ 4\ \alpha$	δ Eridani.		
	8.30	$\alpha = \circ$				$\gamma\ 1\ \circ$	$\eta\ 3\ \circ$	$\circ 3\ \alpha$	$\circ = \delta$		
	9.32	$\alpha\ 1\ \circ$			$\circ 5\ \delta$	$\gamma\ 2\ \circ$	$\eta\ 4\ \circ$	$\circ 3\ \alpha$			
	10.32					$\gamma\ 2\ \circ$	$\eta\ 4\ \circ$	$\circ 3\ \alpha$			
	11.37	$\alpha\ 2\ \circ$			$\circ 5\ \delta$	$\gamma\ 3\ \circ$	$\eta\ 5\ \circ$	$\circ 2\ \alpha$			
	12.29	$\alpha\ 3\ \circ$			$\circ 4\ \delta$	$\gamma\ 4\ \circ$		$\circ 1\ \alpha$	ϵ Eridani.		
	16.29				$\circ 3\ \delta$	$\gamma\ 5\ \circ$		$\alpha\ 1\ \circ$			
	17.29	μ Ceti.			$\circ 3\ \delta$	$\gamma\ 5\ \circ$		$\alpha\ 1\ \circ$	$\epsilon\ 2\ \circ$		
	18.33				$\circ 3\ \delta$	$\gamma\ 5\ \circ$		$\alpha\ 2\ \circ$	$\epsilon\ 2\ \circ$	ξ^2 Ceti.	
	20.30	$\circ 5\ \mu$	ν Piscium.	$\circ$ Piscium.	$\circ 2\ \delta$			$\alpha\ 3\ \circ$		$\circ 4\ \xi^2$	
	23.35	$\circ 4\ \mu$	$\circ 3\ \nu$	$\circ 1\ \circ P.$	$\circ 1\ \delta$			$\alpha\ 5\ \circ$		$\circ 3\ \xi^2$	
	24.30	$\circ 4\ \mu$	$\circ 2\ \nu$	$\circ = \circ P.$	$\circ = \delta$			$\alpha\ 5\ \circ$		$\circ 3\ \xi^2$	
	25.31	$\circ 3\ \mu$	$\circ 1\ \nu$	$\circ P.\ 1\ \circ$	$\delta\ 1\ \circ$					$\circ 2\ \xi^2$	
	28.31	$\circ 1\ \mu$	$\nu\ 1\ \circ$	$\circ P.\ 3\ \circ$	$\delta\ 3\ \circ$	ν Ceti.	λ Ceti.	ν Piscium.	38 Arietis.	$\circ = \xi^2$	
	29.30	$\circ = \mu$	$\nu\ 1\ \circ$	$\circ P.\ 4\ \circ$	$\delta\ 4\ \circ$			$\circ 3\ \xi$		$\xi^2\ 1\ \circ$	
	1859, Jan.	2.27	$\mu\ 1\ \circ$	$\nu\ 3\ \circ$	$\circ P.\ 5\ \circ$	$\delta\ 5\ \circ$			$\circ 1\ \xi$		$\xi^2\ 2\ \circ$
		3.29	$\mu\ 3\ \circ$	$\nu\ 4\ \circ$					$\xi = \circ$		$\xi^2\ 4\ \circ$
		8.29							$\xi\ 2\ \circ$		
9.29					94 Ceti.	$\circ 2\ \nu$	$\lambda\ 1\ \circ$	$\xi\ 3\ \circ$	$\circ 3\ 38$		
10.27					$\circ 3\ 94$	$\circ 1\ \nu$	$\lambda\ 2\ \circ$	$\xi\ 3\ \circ$	$\circ 3\ 38$		
12.27				$\circ 2\ 94$	$\circ 1\ \nu$	$\lambda\ 2\ \circ$	$\xi\ 4\ \circ$				
18.33				94 $2\ \circ$	$\nu\ 4\ \circ$			38 $= \circ$			
20.26	70 Ceti.	63 Ceti.	69 Ceti.	94 $3\ \circ$	$\nu\ 4\ \circ$	$\lambda\ 5\ \circ$		38 $1\ \circ$			
23.26	$\circ 2\ 70$	$\circ 3\ 63$									
24.27	$\circ 1\ 70$	$\circ 2\ 63$	$69\ 1\ \circ$								
26.27	$\circ = 70$	$\circ 1\ 63$	$69\ 2\ \circ$								
27.26	$\circ = 70$	$\circ 1\ 63$	$69\ 2\ \circ$								
31.26	70 $1\ \circ$	63 $= \circ$	69 $3\ \circ$								
Feb.	6.25	70 $3\ \circ$	63 $2\ \circ$	69 $5\ \circ$							
	7.27	70 $3\ \circ$	63 $2\ \circ$	69 $5\ \circ$							

Remarks.

1858.

- Oct. 2. Could not see *Omicron* in a clear sky. The next two nights cloudy.
5. Extremely clear. Windy. Comparisons good. *Omicron* above 6 m.
6. Perfectly clear. Comparisons satisfactory. Oct. 7 was cloudy and stormy.
8. Clear and cool. Aurora Borealis. Stars somewhat difficult to compare, on account of apparent fluctuations in brightness.
9. Clear, except some flying clouds. Windy. Stars somewhat dim and fluctuating. Comparisons not good. Cloudiness soon followed.
10. Clear, except occasionally a flying cloud. Very little wind. Comparisons carefully made, but not so good as desirable. That with λ poor. Brightness fluctuating.
11. Remarkably clear. No wind. Stars steady and brilliant. Comparisons very satisfactory. Oct. 12 and 13, stormy.
14. Clear. Somewhat windy. Stars varying in brightness. Comparisons pretty good.
15. Clear, except near the horizon. Comparisons good. Oct. 16 and 17, cloudy.
18. Clear, but stars not constant in brightness. Moonlight troublesome. Oct. 19 – 24, unfit for observations.
25. Very clear, bright moonlight. Comparisons good. Color of *Omicron* reddish-yellow.
26. Pretty clear. A slight haziness near *Omicron* prevented very good comparisons.
27. Clear, with brilliant Aurora. Color of *Omicron* yellowish.
28. Sky remarkably clear. Light breeze. Oct. 29 – 31, unfit for observation.
- Nov. 1. Clear. Comparisons carefully made. Color of *Omicron* reddish-yellow, resembling that of β *Andromedæ*. Further comparisons prevented by haziness.
2. Remarkably clear. Comparisons good. Color of *Omicron* reddish-yellow. It does not appear so sharp as most stars of same magnitude; but seems to have a somewhat nebulous appearance. Nov. 3 – 7, cloudy or stormy.
8. Cloudy, with occasionally an opening of considerable area, through which the stars appeared with varying brightness. Comparison unsatisfactory. Nov. 9 and 10, cloudy.
11. Clear. Comparisons good. *Omicron* considerably redder than a few days before: about the color of γ *Eridani*.
12. Remarkably clear. Comparisons very good. *Omicron* yellowish-red. Nov. 13, cloudy.
14. Clear, but stars somewhat fluctuating in brightness. Comparisons not very good. Clouds prevented further comparisons.
15. Generally clear. Comparisons difficult, and results not good. *Omicron* pale red. Nov. 16, cloudy. Although Nov. 17 was generally clear, clouds near *Omicron* prevented observations. The next three days cloudy.
21. Clear, but moonlight bright. Comparisons good.
22. Remarkably clear sky. Stars constant, but moonlight somewhat troublesome. Comparisons very carefully made. Color of *Omicron* nearly equal to that

1858. of δ *Andromedæ*. The next six nights were unfit for observing.
- Nov. 29. Remarkably clear. Comparisons good. *Omicron* not so red as δ *Andromedæ*.
30. Sky clear. Comparisons fair. Heavy wind.
- Dec. 1. Perfectly clear. A strong wind. Comparisons pretty good. The next four nights cloudy.
6. Clear, except a few flying clouds. Comparisons pretty good. *Omicron* of a bright orange color, and somewhat indistinct, as if enveloped in a slight haziness: a very common phenomenon for this star. Dec. 7, stormy.
8. Very clear. Comparisons good. *Omicron* appears to be enveloped in a haziness, not a thickness of the atmosphere, but something belonging to the starlight itself.
9. Clear. Comparisons pretty good.
10. Clear near *Omicron* and comparison-stars. Comparisons not very good.
11. Very clear. Comparisons very good.
12. Clear. Comparisons pretty good. Dec. 13, 14, 15, cloudy.
16. Very clear. Moonlight bright, making observations difficult. Comparisons tolerably good.
17. Very clear. Moon farther from *Omicron* than on the 16th. Comparisons carefully made. *Omicron* pale yellow.
18. Clear. Comparisons good, but moonlight troublesome. Dec. 19 was stormy.
20. Clear. Bright moon, but comparisons good. Dec. 21 and 22, cloudy.
23. Clear. Color of *Omicron* yellowish-white. Comparisons pretty good.
24. Remarkably clear. *Omicron* yellower.
25. Very clear. The next two days cloudy.
28. Very clear. Color of *Omicron* bluish-white.
29. Remarkably clear. Dec. 30, 31, and Jan. 1, cloudy.
- 1859.
- Jan. 2. Pretty clear. Comparisons of average value. *Omicron* white.
3. Sky clear. Comparisons pretty good. Jan. 4 – 7, cloudy or stormy.
8. Clear and cold. Moonlight troublesome on account of dimness of *Omicron*. Comparisons carefully made.
9. Very clear, but windy. Moonlight troublesome, but comparisons satisfactory.
10. Clear, and stars brilliant. Comparisons good. Color of *Omicron* white. Jan. 11 – 17, unfit for observations.
18. Clear, with bright moonlight. *Omicron* white. Jan. 19, cloudy.
20. Clear. *Omicron* difficult to observe on account of faintness. Comparisons carefully made. *Omicron* white. The next two nights cloudy.
23. Clear. Comparisons good.
24. Clear. Comparisons good. Jan. 25, cloudy.
26. Clear. *Omicron* of a bright white color. Comparisons good.
27. Very clear. *Omicron* white. Comparisons good. Jan. 28 – 30, cloudy.
31. Clear. Comparisons carefully made. Feb. 1 – 5, cloudy.

1859.

Feb. 6. Some flying clouds. Comparisons difficult, on account of moonlight and dimness of *Omicron*.7. Very clear, but moonlight troublesome. *Omicron* very white. Feb. 8 and 9, cloudy.

1859.

Feb. 10 – 12 were clear, but the bright moonlight rendered *Omicron* invisible. The 13th to 21st were unfit for observing. Feb. 22 – 27, very clear. *Omicron* scarcely visible to the naked eye; being a faint 6 m.*Observed Maximum, from the Mean of Comparisons between October 26 and November 22, 1858,*

with α <i>Trianguli</i> : — Nov. 9.615	with ζ <i>Persei</i> : — Nov. 9.940 7.973 } Nov. 8.776 8.415 }	with γ <i>Ceti</i> : — Nov. 9.143	with γ <i>Eridani</i> : — Nov. 6.480
with β <i>Trianguli</i> : — Nov. 8.510 8.415 } Nov. 8.606 8.893 }	with β <i>Arietis</i> : — Nov. 8.010 8.655 } Nov. 8.333	with δ <i>Andromedæ</i> : — Nov. 8.510	with ε <i>Persei</i> : — Nov. 11.915 8.665 } Nov. 9.990 9.390 }

Resulting observed maximum from mean of all, 1858, November 8.682, W. M. T.

I have not yet determined the photometrical magnitudes and am hence unable to give, at present, the observed magnitudes of this star.

Weld, Maine, 1859, April 12.

OBSERVATIONS OF IRENE.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — Corrected for refraction.]

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽¹⁴⁾ — *	$\Delta\delta$	α ⁽¹⁴⁾ 's apparent	δ
1859, Apr.	1 9 ^h 25 ^m 48.6 ^s	13	Weisse XII. 665	—0 ^m 39.94 ^s	+ 0 ['] 34.63 ["]	12 38 54.53	+13 44 ['] 24.15 ["]
	4 9 56 56.1	7	" 626	—1 13.03	—14 11.60	12 36 19.33	13 52 47.63
	9 53 2.1	6	" 646	—2 5.99	—18 7.74	12 36 18.61	13 52 44.74
	5 9 45 20.1	10	" 626	—2 4.08	—12 0.71	12 35 28.28	13 54 58.86
	12 9 8 45.4	21	" 497	—0 27.64	+17 12.05	12 29 50.62	14 2 30.91
	16 8 56 29.1	14	" 461.	—1 4.27	+17 43.20	12 26 58.63	+14 0 25.08

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
Weisse XII. 665	9	12 39 34.89	+13 43 47.01	Weisse's Catalogue.
" 626	9	12 37 32.66	14 6 56.69	
" 646	8	12 38 24.94	14 10 48.62	
" 497	8	12 30 18.56	13 45 14.90	
" 461	9	12 28 3.20	+13 42 37.45	

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NO. 6.

ON SOME RELATIONS OF THE PARABOLIC MOTION.

By GEORGE SEARLE,

LATE ASSISTANT AT THE DUDLEY OBSERVATORY.

THE introduction of an auxiliary angle seems to give a neat form to some relations of the parabolic motion. Denoting by r, r' , two radius-vectors in a parabolic orbit, and by c the chord connecting them, t, t', v, v' being the corresponding times and anomalies; and putting for convenience $v' - v = \Delta v$ (v, v' being taken negative before perihelion); if we make $\sqrt{\frac{r'}{r}} =$

$\tan \omega, \frac{c}{r+r'} = \sin \chi, \chi$ being in the same quadrant with $\frac{1}{2} \Delta v$, we may obtain the following equations:—

$$\cos \chi = \sin 2\omega \cos \frac{1}{2} \Delta v.$$

l and $-L$ (*Theoria Motus*, § 88, [9, 9*]) = $\frac{1}{2} (\sec \chi - 1)$ = $\frac{\sin^2 \frac{1}{2} \chi}{\cos \chi}$; and from § 98 are readily obtained,

$$\sqrt{\frac{2}{3}} (1 + \frac{1}{2} \cos \chi) \sqrt{1 - \cos \chi} = \sin \frac{1}{2} \chi - \frac{2}{3} \sin^3 \frac{1}{2} \chi = \cos^3 \frac{1}{2} \chi (\tan \frac{1}{2} \chi + \frac{1}{3} \tan^3 \frac{1}{2} \chi) = \frac{k(t' - t)}{(r + r')^{\frac{3}{2}}} = \frac{k(t' - t) \sin^{\frac{3}{2}} 2\omega}{\sqrt{8} (r r')^{\frac{3}{2}}}.$$

$$\cos \frac{1}{2} v = \frac{\sin \omega \sin \frac{1}{2} \Delta v}{\sqrt{2} \sin \frac{1}{2} \chi}; \quad \cos \frac{1}{2} v' = \frac{\cos \omega \sin \frac{1}{2} \Delta v}{\sqrt{2} \sin \frac{1}{2} \chi};$$

(the signs of v, v' , being determined by the value of Δv),

the perihelion distance,

$$q = \frac{\sqrt{r r'} \cdot \sin^2 \frac{1}{2} \Delta v \sin 2\omega}{4 \sin^2 \frac{1}{2} \chi},$$

the $\frac{\text{sector}}{\text{triangle}}$,

$$\eta = \pm \left(\frac{1}{3} + \frac{2}{3 \cos \chi} \right),$$

the upper or lower sign being used as Δv is greater or less than 180° .

The time of perihelion-passage might be obtained by the expression

$$T = t - \frac{\sqrt{2}}{k} \cdot r^{\frac{3}{2}} (\sin \frac{1}{2} v - \frac{2}{3} \sin^3 \frac{1}{2} v) = t' - \frac{\sqrt{2}}{k} \cdot r'^{\frac{3}{2}} (\sin \frac{1}{2} v' - \frac{2}{3} \sin^3 \frac{1}{2} v'),$$

though this would probably be no improvement upon the ordinary method.

The second of the above formulas may also be derived from Lambert's equation; and when $r = r'$, and $v = -v'$, it evidently becomes the common equation for getting v from $(t - T)$.

By means of these, $\Delta v, q, v, v', \eta$ may be easily obtained from r, r' , and $t' - t$.

This method of solving Lambert's equation is not altogether unlike that attached to OLBERS's computation of the orbit of a comet, where $\eta = 2 (\sin \frac{1}{2} \chi - \frac{2}{3} \sin^3 \frac{1}{2} \chi)$, for which $\mu = \frac{\sin \chi}{\eta}$ is tabulated.

The following additional relations of χ may not be uninteresting. Representing the sun by S, and the two points in orbit by P, P', if we draw tangents to the orbit at these points meeting at a point Q, and denote by T the point where the line S Q (which bisects the angle P S P' by a general property of the conic sections) cuts the chord P P', we have the following values of various quantities:—

$$S P' Q = S Q P = 90^\circ - \frac{1}{2} v'$$

$$P' Q S = Q P S = 90^\circ + \frac{1}{2} v$$

$$P Q P' = 180^\circ - \frac{1}{2} \Delta v$$

$$\sin P' P Q = \tan \frac{1}{2} \chi \cos \frac{1}{2} v$$

$$\sin P P' Q = \tan \frac{1}{2} \chi \cos \frac{1}{2} v'$$

$$\sin S T P = \frac{\sin \frac{1}{2} \Delta v}{\sin \chi}$$

$$P T = r \sin \chi; P' T = r' \sin \chi$$

$$P Q = \frac{r \sin \frac{1}{2} \Delta v}{\cos \frac{1}{2} v'} = \frac{\sqrt{2} \cdot r \sin \frac{1}{2} \chi}{\cos \omega}$$

$$P' Q = \frac{r' \sin \frac{1}{2} \Delta v}{\cos \frac{1}{2} v} = \frac{\sqrt{2} \cdot r' \sin \frac{1}{2} \chi}{\sin \omega}$$

$$S Q = \sqrt{r r'}; S T = \pm S Q \cdot \cos \chi$$

$$\frac{\text{triangle } S P P'}{S P Q P'} = \pm \cos \chi$$

$$\frac{\text{sector } S P P'}{S P Q P'} = \frac{2 + \cos \chi}{3}$$

DETERMINATION OF THE ORBIT OF NEMAUSA.

By T. H. SAFFORD.

THIS planet, the fifty-first of the asteroid-group, was observed during the months of February, March, April, May, and part of June, 1858. The observations in February, were made at Marseilles, and it was found difficult to make use of them, as they were separated from the rest by a large interval, and were only two in number.

The following normal places were derived by comparison with a set of approximate elements derived from three observations.

Washington M. T.	(51) α	(51) δ	No. Obs.
1858, March 7.5	175° 42' 25.4"	+1° 36' 37.2"	7
25.5	172 11 16.6	4 1 11.5	10
April 23.0	169 14 34.6	7 48 44.1	16
May 16.5	170 58 1.9	8 26 14.7	8
June 3.5	174 30 15.5	+7 36 43.4	6

The logarithms of the geocentric distance Δ , given by the above-mentioned elements, at the first and last of these dates were:—

March 7.5 0.087165; June 3.5 0.261863.

From these, assumed as true, and the corresponding right-ascensions and declinations given above, the approximate elements to be afterwards corrected were derived.

These were:—

Epoch 1858, March 7.5,

$$\left. \begin{array}{l} L^{\circ} \quad 172^{\circ} 30' 45.7'' \\ \pi^{\circ} \quad 176 \quad 14 \quad 9.5 \\ \Omega^{\circ} \quad 175 \quad 39 \quad 11.6 \\ q^{\circ} \quad 3 \quad 48 \quad 9.2 \\ i^{\circ} \quad 9 \quad 56 \quad 38.3 \\ \mu^{\circ} \quad 16 \quad 14.987 \end{array} \right\} \text{M. Eq. 1858.0}$$

Comparing these elements with the above normals II. III. IV, we find:—

	$\Delta \alpha$	C. - O.	$\Delta \delta$
March 25.5	—0.8		—3.0
April 23.0	9.1		—2.0
May 16.5	—8.3		+3.4

The assumed distances were then corrected by the process given by myself in the Memoirs of the American Academy, Vol. VI. The eccentricity is so small, however, that I thought it best to use, as variables, instead of q and χ (where $d\chi = d\pi + (1 - \cos i) d\Omega$) the following:—

$$\xi = e \cos (\chi - \pi^{\circ}) - e^{\circ}$$

$$\eta = e \sin (\chi - \pi^{\circ}).$$

The reason for preferring them was, that it seemed (see that part of Mr. HANSEN's memoir on the computation of perturbations, *A. N.*, No. 799, 800, which treats of the computation of new elements from his dC , r , z_0 , and their first derivatives with regard to the time) to be the safest way of avoiding changes in the computed places from those derived from the differential coefficients with respect to the elements.

This change of variables seems especially useful where, as in my method, the variation of L is used implicitly, and is at last actually determined so that two places at least are represented.

The variations of the assumed logarithms of Δ , which best satisfied the observed values of the geocentric orbit-longitude η , were —6 and +105 in the sixth place of decimals; so that we have:—

$$\text{March 7.5 } \log \Delta = 0.087159$$

$$\text{June 3.5 } \quad \quad \quad 0.262268.$$

From the values of $\frac{d\eta}{dL_1}$, $\frac{d\eta}{dL_2}$, $\frac{d\chi}{dL_1}$, $\frac{d\chi}{dL_2}$, obtained in the course of the computation, $\delta\eta$, $\delta\chi$ were computed; but were not applied to the quantities whose corrections they were nominally.

Instead, I made

$$\xi = \cos q^{\circ} \delta\eta = e \cos (\chi - \pi^{\circ}) - e^{\circ}$$

$$\eta = \sin q^{\circ} \delta\chi = e \sin (\chi - \pi^{\circ}).$$

These gave the new values of χ and $\sin q$. I then substituted the new values of $\log \Delta$, in the equations for the two sets of heliocentric coördinates, and thence obtained the new values of Ω and i , and of the argument of latitude and radius-vector for March 7.5 and June 3.5. The value of $\chi - \pi^{\circ}$ being

$$\omega = \omega^\circ + \cos i (\Omega - \Omega^\circ)$$

(where $\omega = \pi - \Omega$) gave at once ω .

Having now $v = u - \omega$, the true anomaly in the corrected orbit, the mean anomaly was at once deduced from this and the corrected eccentricity. The corrected radius-vectors gave, by the help of φ and v , two values of the semiparameter p , precisely agreeing. Then the difference between the mean anomalies gave the *log* semiaxis major, agreeing, within one of the last decimal place used, with that derived from p and φ . Moreover, the same value of *log a* was obtained from its derivatives (before computed) with respect to Δ_1 and Δ_2 .

Finally, the mean anomaly was referred to a convenient epoch, L and π found by adding their separate parts, and the elements thus collected:—

Epoch 1858, May 0.0, Washington,

L	186° 49' 45.0"	} Mean Equinox of date.
π	174° 49' 46.0"	
Ω	175° 39' 11.2"	
φ	3° 47' 41.5"	
i	9° 57' 2.1"	
μ	16 15.072	

It will be seen that π has been changed more than 1° ; thus the modification given above has been found highly desirable. It now remains to compare these elements with the normals again. The system of controls given above insures an accurate representation of the first and last places, provided no gross error has been committed in the last operation, or in changing the elements from the equator to the ecliptic. For precisely the reverse of *all* the operations has been performed which would have to be gone through with to compute the places from the elements. By the process used in computing u_1 , u_2 , and r_1 , r_2 , from the heliocentric coördinates, no error can easily have been committed, so many well-known tests have been employed.

The other normal places are thus represented:—

	$\Delta\alpha$	C. — O.	$\Delta\delta$
March 25.5	—0.8		+1.3
April 23.0	+0.1		—1.2
May 16.5	+0.5		+3.0

These remaining errors are almost entirely in the direction perpendicular to the orbit, and could be diminished by changing the node and inclination. In this case these errors would be distributed over five places, instead of being confined to three; but the first and last normals would no longer be exactly represented.

It would evidently be unsafe to attempt to represent the declinations better at the expense of the right-ascensions; the latter are much more strongly affected than the former by varying the two unknown quantities (the values of *log Δ*) on which the elements depend, and consequently less in comparison by the errors of the two fundamental normals which were perfectly represented.

The changes in the node and inclination requisite to represent the declinations better would be of very little effect upon the ephemeris, and therefore have not been made.

The following opposition-ephemeris has been corrected for the disturbing effect of *Jupiter*.

I may venture to add, that I feel much interested in procuring as many observations of *Nemausa* as possible during the opposition-month, as I hope to be able at some future time to compute tables of it.

Ephemeris of Nemausa, for the Opposition, 1859.

Wash. Noon.	(51) α	(51) δ	Log. Δ	Log. r
July 26	321° 35' 51.9"	—3° 43' 28.9"	0.179365	0.394622
27	321 24 6.1	3 49 2.5		
28	321 12 4.7	3 54 47.5		
29	320 59 51.6	4 0 43.6		
30	320 47 27.7	4 6 50.5	0.175672	0.394956
31	320 34 53.8	4 13 7.8		
Aug. 1	320 22 10.9	4 19 35.2		
2	320 9 20.0	4 26 12.4		
3	319 56 22.3	4 32 59.0	0.173123	0.395284
4	319 43 18.7	4 39 54.5		
5	319 30 10.2	4 46 58.6		
6	319 16 57.7	4 51 10.9		
7	319 3 42.3	5 1 31.0	0.171766	0.395604
8	318 50 24.8	5 8 58.6		
9	318 37 6.3	5 16 33.2		
10	318 23 47.8	5 24 14.4		
11	318 10 30.2	5 32 1.7	0.171640	0.395918
12	317 57 14.4	5 39 54.8		
13	317 44 1.4	5 47 53.1		
14	317 30 52.2	5 55 56.2		
15	317 17 47.7	6 4 3.8	0.172747	0.396224
16	317 4 49.0	6 12 15.3		
17	316 51 56.9	6 20 30.3		
18	316 39 12.4	6 28 48.4		
19	316 26 36.4	6 37 9.1	0.175080	0.396522
20	316 14 10.1	6 45 32.1		
21	316 1 54.1	6 53 56.8		
22	315 49 49.5	7 2 22.8		
23	315 37 57.1	7 10 49.6	0.178605	0.396813
24	315 26 17.8	7 19 16.6		
25	315 14 52.3	7 27 43.4		
26	315 3 41.7	7 36 9.7		
27	314 52 46.7	7 44 34.9	0.183279	0.397096
28	314 42 8.1	7 52 58.8		
29	314 31 46.8	8 1 20.9		
30	314 21 43.5	8 9 40.8		
31	314 11 59.0	—8 17 58.1	0.189024	0.397372

The *Berliner Jahrbuch* estimates its magnitude as the 10th, at the opposition; this will take place August 11.

OBSERVATIONS OF ALGOL-MINIMA.

MADE AT WELD, FRANKLIN COUNTY, MAINE.

By STILLMAN MASTERMAN.

Minimum +7477, — 1858, September 13.

Watch Time.	Comparison.		
	δ	ϱ	*
^h ^m 12 12	$\delta = \beta$	$\beta 3 \varrho$	$\beta 4 *$
18	$\frac{1}{2}$	2	3
24	1	$1\frac{1}{2}$	3
30	2	1	2
36	2	1	2
42	2	$1\frac{1}{2}$	3
48	1	$1\frac{1}{2}$	3
12 54	$\frac{1}{2}$	2	4
13 0	$\frac{1}{2}$	3	4
6	=	3	4
13 12	$\delta = \beta$	$\beta 3 \varrho$	$\beta 4 *$

Observed Time of Minimum.

By comparison with δ : — with ϱ : — with * : —
^h ^m ^h ^m ^h ^m
 12 37.50 12 35.63 12 34.50
 (weight, 2.) (weight, 4.) (weight, 1.)

Final mean, ^h ^m
 Cor. for Watch-error, —0.20
 12 35.80
 Long. E. from Washington, 26.65
 Observed Minimum, Sept. 13, 12 9.15 W. M. T.

Minimum +7485, — 1858, October 6.

Watch Time.	Comparison.		
	δ	ϱ	ε
^h ^m 10 30	$\delta \frac{1}{2} \beta$	$\beta 1\frac{1}{2} \varrho$	$\varepsilon 1\frac{1}{2} \beta$
36	1	$1\frac{1}{2}$	2
42	$1\frac{1}{2}$	1	2
48	2	$\frac{1}{2}$	3
10 54	$2\frac{1}{2}$	$\frac{1}{2}$	3
11 0	$2\frac{1}{2}$	= ϱ +	3
6	$2\frac{1}{2}$	= ϱ +	3
12	$2\frac{1}{2}$	= ϱ +	3
18	$2\frac{1}{2}$	= ϱ +	3
24	$2\frac{1}{2}$	$\frac{1}{2}$	3
30	$2\frac{1}{2}$	$\frac{1}{2}$	3
36	2	$\frac{1}{2}$	3
42	2	1	2
48	$1\frac{1}{2}$	1	2
11 54	$\delta 1 \beta$	$\beta 1\frac{1}{2} \varrho$	$\varepsilon 1\frac{1}{2} \beta$

Observed Time of Minimum.

By comparison with δ : — with ϱ : — with ε : —
^h ^m ^h ^m ^h ^m
 11 13.87 11 11.62 11 12.00
 (weight, 1.) (weight, 2.) (weight, 1.)

Final mean, ^h ^m
 Correction for Watch-error, +0.50
 11 12.28
 Long. E. from Washington, 26.65
 Observed Minimum, Oct. 6, 10 46.13 W. M. T.

Minimum +7492, — 1858, October 26.

Watch Time.	Comparison.		
	δ	ϱ	ε
^h ^m 12 0	$\delta = \beta$	$\beta 2 \varrho$	$\varepsilon 1 \beta$
6	=	2	2
12	1	$1\frac{1}{2}$	$2\frac{1}{2}$
18	$1\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{2}$
24	2	1	3
30	2	$\frac{1}{2}$	3
36	2	$\frac{1}{2}$	$3\frac{1}{2}$
42	$2\frac{1}{2}$	$\frac{1}{2}$	$3\frac{1}{2}$
48	$2\frac{1}{2}$	$\frac{1}{2}$	$3\frac{1}{2}$
12 54	$2\frac{1}{2}$	$\frac{1}{2}$	$3\frac{1}{2}$
13 0	$2\frac{1}{2}$	$\frac{1}{2}$	$3\frac{1}{2}$
6	2	1	3
12	$1\frac{1}{2}$	1	3
18	$1\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{2}$
24	$1\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{2}$
30	1	2	$\varepsilon 2\frac{1}{2} \beta$
13 36	$\delta 1 \beta$	$\beta 2 \varrho$	

Observed Time of Minimum.

By comparison with δ : — with ϱ : — with ε : —
^h ^m ^h ^m ^h ^m
 12 49.88 12 46.88 12 48.50
 (weight, 1.) (weight, 2.) (weight, 1.)

Final mean, ^h ^m
 Correction for Watch-error, —0.20
 12 47.83
 Long. E. from Washington, 26.65
 Observed Minimum, Oct. 26, 12 21.18 W. M. T.
 (Observation not very satisfactory.)

Minimum +7501, — 1858, November 21.

Watch Time.	Comparison.			
	δ Persei.	ϱ Persei.	α Trianguli.	β Trianguli.
^h ^m	$\beta \frac{1}{2} \delta$	$\beta 2\frac{1}{2} \varrho$	$\beta 1\frac{1}{2} \alpha$	$\beta \tau. 1 \beta$
7 18		$\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$
24	$\delta = \beta$	2	$1\frac{1}{2}$	$1\frac{1}{2}$
30		$1\frac{1}{2}$	1	2
36	$\frac{1}{2}$	1	$\frac{1}{2}$	2
42	$\frac{1}{2}$	1	$\frac{1}{2}$	2
48	1	1	$\frac{1}{2}$	$2\frac{1}{2}$
7 54	$1\frac{1}{2}$	$\frac{1}{2}$	=	$2\frac{1}{2}$
8 0	$1\frac{1}{2}$	$\frac{1}{2}$	$\alpha = \beta$	$2\frac{1}{2}$
6	2	=	$\frac{1}{2}$	3
12	2	=	$\frac{1}{2}$	3
18	2	=	$\frac{1}{2}$	3
24	$1\frac{1}{2}$	$\frac{1}{2}$	=	3
30	$1\frac{1}{2}$	1	$\beta = \alpha$	$2\frac{1}{2}$
36	1	1	$\frac{1}{2}$	$2\frac{1}{2}$
42	1	$1\frac{1}{2}$	1	2
48	$\frac{1}{2}$	2	$1\frac{1}{2}$	2
8 54	$\frac{1}{2}$	$\beta 2 \varrho$	$1\frac{1}{2}$	$1\frac{1}{2}$
9 0	$\beta = \delta$		$\beta 2 \alpha$	$\beta \tau. 1\frac{1}{2} \beta$

Observed Time of Minimum.

By comparison with δ : —	with ϱ : —
^h ^m	^h ^m
8 13.50	8 9.90
(weight, 3.)	(weight, 6.)
with α Trianguli : —	with β Trianguli : —
^h ^m	^h ^m
8 10.20	8 13.13
(weight, 2.)	(weight, 1.)
Final mean,	^h ^m
Correction for Watch-error,	8 11.12
	+0.23
	8 11.35
Long. E. from Washington,	26.65
Observed Minimum, Nov. 21,	7 44.70 W. M. T.

Minimum +7508, — 1858, December 11.

Watch Time.	Comparison.			
	δ Persei.	ϱ Persei.	α Trianguli.	β Trianguli.
^h ^m	$\delta = \beta$	$\beta 2\frac{1}{2} \varrho$	$\beta 1\frac{1}{2} \alpha$	$\beta \tau. 1 \beta$
9 2		2	$1\frac{1}{2}$	$1\frac{1}{2}$
8	$\frac{1}{2}$	2	$1\frac{1}{2}$	2
14	1	2	1	$2\frac{1}{2}$
20	$1\frac{1}{2}$	$1\frac{1}{2}$	=	$2\frac{1}{2}$
26	2	1	$\beta = \alpha$	3
32	2	$\frac{1}{2}$	$\alpha \frac{1}{2} \beta$	$3\frac{1}{2}$
38	$2\frac{1}{2}$	=	$\frac{1}{2}$	$3\frac{1}{2}$
44	$2\frac{1}{2}$	=	$\frac{1}{2}$	$3\frac{1}{2}$
50	$2\frac{1}{2}$	=	$\frac{1}{2}$	$3\frac{1}{2}$
9 56	2	$\frac{1}{2}$	$\alpha \frac{1}{2} \beta$	3
10 2	2	$\frac{1}{2}$	$\beta = \alpha$	3
8	$1\frac{1}{2}$	1	1	$2\frac{1}{2}$
14	$1\frac{1}{2}$	$1\frac{1}{2}$	1	2
20	1	2	$1\frac{1}{2}$	2
26	1	$2\frac{1}{2}$	2	$1\frac{1}{2}$
10 32	$\delta \frac{1}{2} \beta$	$\beta 2\frac{1}{2} \varrho$	$\beta 2 \alpha$	$\beta \tau. 1\frac{1}{2} \beta$

Observed Time of Minimum.

By comparison with δ : —	with ϱ : —
^h ^m	^h ^m
9 46.10	9 45.75
(weight, 3.)	(weight, 6.)
with α Trianguli : —	with β Trianguli : —
^h ^m	^h ^m
9 45.88	9 45.80
(weight, 2.)	(weight, 1.)
Final mean,	^h ^m
Correction for Watch-error,	9 45.94
	—0.25
	9 45.69
Long. E. from Washington,	26.65
Observed Minimum, Dec. 11,	9 19.04 W. M. T.

Minimum +7514, — 1858, December 28.

Watch Time.	Comparison.		
	δ	ϱ	*
^h ^m			
13 54	$\delta 1 \beta$	$\beta 3 \varrho$	$\beta 2 *$
14 0	1	3	2
6	$1\frac{1}{2}$	2	2
12	$1\frac{1}{2}$	2	1
18	2	$1\frac{1}{2}$	1
24	2	$1\frac{1}{2}$	1
30	$2\frac{1}{2}$	$1\frac{1}{2}$	1
36	3	1	=
42	3	1	=
48	3	1	=
14 54	3	1	=
15 0	3	1	=
6	$2\frac{1}{2}$	$1\frac{1}{2}$	1
12	2	$1\frac{1}{2}$	1
18	2	2	1
24	$1\frac{1}{2}$	2	2
15 30	$\delta 1\frac{1}{2} \beta$	$\beta 2 \varrho$	$\beta 2 *$

Observed Time of Minimum.

By comparison with δ : —	with ϱ : —	with * : —
^h ^m	^h ^m	^h ^m
14 48.00	14 47.00	14 46.00
(weight, 3.)	(weight, 6.)	(weight, 1.)
Final mean,	^h ^m	
Correction for Watch-error,	14 47.20	
	—0.45	
	14 46.75	
Long. E. from Washington,	26.65	
Observed Minimum, Dec. 28,	14 20.10 W. M. T.	

Minimum +7523, — 1859, January 23.

Watch Time.	Comparison.			
	δ Persei.	ρ Persei.	α Trianguli.	β Trianguli.
^h ^m	$\delta = \beta$	$\beta 2\frac{1}{2} \rho$	$\beta 1\frac{1}{2} \alpha$	$\beta \tau. 1\frac{1}{2} \beta$
9 18	1	2	1	2
24	1 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$	2
30	1 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$	2 $\frac{1}{2}$
36	2	1	=	3
42	2	1	=	3
48	2 $\frac{1}{2}$	$\frac{1}{2}$	$\alpha \frac{1}{2} \beta$	3 $\frac{1}{2}$
9 54	3	=	$\frac{1}{2}$	4
10 0	3	=	$\frac{1}{2}$	4
6	3	=	$\frac{1}{2}$	4
12	3	=	=	4
18	2 $\frac{1}{2}$	$\frac{1}{2}$	=	3 $\frac{1}{2}$
24	2	1	$\beta \frac{1}{2} \alpha$	3
30	2	1	1	3
36	1 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$	3
42	1 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$	2 $\frac{1}{2}$
48	$\delta 1 \beta$	$\beta 2 \rho$	$\beta 1\frac{1}{2} \alpha$	$\beta \tau. 2 \beta$

Observed Time of Minimum.

By comparison with δ : —	with ρ : —
^h ^m	^h ^m
10 9.00	10 9.00
(weight, 3.)	(weight, 6.)
with α Trianguli : —	with β Trianguli : —
^h ^m	^h ^m
10 2.10	10 10.20
(weight, 2.)	(weight, 1.)
Final mean,	^h ^m
Correction for Watch-error,	10 7.95
	—1.03
	10 6.92
Long. E. from Washington,	26.65
Observed Minimum, Jan. 23,	9 40.27 W. M. T.

Minimum +7524, — 1859, January 26.

Watch Time.	Comparison.			
	δ Persei.	ρ Persei.	α Trianguli.	β Trianguli.
^h ^m	$\delta 1 \beta$	$\beta 1\frac{1}{2} \rho$	$\beta 2 \alpha$	$\beta \tau. 2 \beta$
6 12	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	2 $\frac{1}{2}$
18	1 $\frac{1}{2}$	1	1 $\frac{1}{2}$	2 $\frac{1}{2}$
24	2	$\frac{1}{2}$	1	3
30	2 $\frac{1}{2}$	$\frac{1}{2}$	=	3 $\frac{1}{2}$
36	2 $\frac{1}{2}$	=	=	3 $\frac{1}{2}$
42	3	=	$\alpha \frac{1}{2} \beta$	4
48	3	=	$\frac{1}{2}$	4
6 54	2 $\frac{1}{2}$	$\frac{1}{2}$	=	3 $\frac{1}{2}$
7 0	2 $\frac{1}{2}$	$\frac{1}{2}$	=	3 $\frac{1}{2}$
6	2	1	$\beta 1 \alpha$	3
12	2	1	1	3
18	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1	2 $\frac{1}{2}$
24	1	2	1 $\frac{1}{2}$	2
30	1	2	1 $\frac{1}{2}$	2
36	$\delta = \beta$	$\beta 3 \rho$	$\beta 2 \alpha$	$\beta \tau. 1\frac{1}{2} \beta$

Observed Time of Minimum.

By comparison with δ : —	with ρ : —
^h ^m	^h ^m
6 51.90	6 48.75
(weight, 3.)	(weight, 6.)
with α Trianguli : —	with β Trianguli : —
^h ^m	^h ^m
6 54.00	6 51.90
(weight, 2.)	(weight, 1.)
Final mean,	^h ^m
Correction for Watch-error,	6 50.68
	—0.72
	6 49.96
Long. E. from Washington,	26.65
Observed Minimum, Jan. 26,	6 23.31 W. M. T.

Minimum +7530, — 1859, February 12.

Watch Time.	Comparison.			
	δ Persei.	ρ Persei.	ϵ Aurigæ.	η Aurigæ.
^h ^m	$\delta 1\frac{1}{2} \beta$	$\beta 2 \rho$	$\epsilon \frac{1}{2} \beta$	$\rho 1 \eta$
11 6	1 $\frac{1}{2}$	2	$\frac{1}{2}$	1
12	2	1 $\frac{1}{2}$	1	$\frac{1}{2}$
18	2	1 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$
24	2	1	1 $\frac{1}{2}$	=
30	2 $\frac{1}{2}$	1	2	$\beta = \eta$
36	3	$\frac{1}{2}$	2	$\eta \frac{1}{2} \beta$
42	3	$\frac{1}{2}$	2	$\frac{1}{2} \beta$
48	3	$\frac{1}{2}$	2	$\frac{1}{2} \beta$
11 54	3	$\frac{1}{2}$	2	$\eta \frac{1}{2} \beta$
12 0	2 $\frac{1}{2}$	1	1 $\frac{1}{2}$	$\beta = \eta$
6	2 $\frac{1}{2}$	1	1 $\frac{1}{2}$	=
12	2 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$
18	2	1 $\frac{1}{2}$	1 $\frac{1}{2}$	$\frac{1}{2}$
24	2	2	1	1
12 30	$\delta 1\frac{1}{2} \beta$	$\beta 2 \rho$	$\epsilon \frac{1}{2} \beta$	$\rho 1 \eta$

Observed Time of Minimum.

By comparison with δ : —	with ρ : —
^h ^m	^h ^m
11 50.25	11 48.00
(weight, 4.)	(weight, 8.)
with ϵ Aurigæ : —	with η Aurigæ : —
^h ^m	^h ^m
11 48.38	11 48.00
(weight, 2.)	(weight, 3.)
Final mean,	^h ^m
Correction for Watch-error,	11 48.63
	—0.10
	11 48.53
Long. E. from Washington,	26.65
Observed Minimum, Feb. 12,	11 21.88 W. M. T.

Minimum +7539, — 1859, March 10.

Watch Time.	Comparison.		
	δ	ϱ	ε <i>Aurige</i> .
^h ^m 6 48	δ 2 β	β 1 ϱ	ε 2 β
6 54	2 $\frac{1}{2}$	$\frac{1}{2}$	2
7 0	2 $\frac{1}{2}$	$\frac{1}{2}$	2 $\frac{1}{2}$
6	3	=	3
12	3	=	3
18	3	=	3
24	2 $\frac{1}{2}$	$\frac{1}{2}$	2 $\frac{1}{2}$
30	2 $\frac{1}{2}$	$\frac{1}{2}$	2
36	2	1	2
42	2	1	2
48	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$
7 54	δ 1 $\frac{1}{2}$ β	β 2 ϱ	ε 1 $\frac{1}{2}$ β

Observed Time of Minimum.

By comparison with δ : —	with ϱ : —	with ε : —
^h ^m 7 12.50	^h ^m 7 12.50	^h ^m 7 12.50
(weight, 2.)	(weight, 4.)	(weight, 1.)
Final mean,	^h ^m 7 12.50	
Correction for Watch-error,	—0.20	
	7 12.30	
Long. E. from Washington,	26.65	
Observed Minimum, March 10,	6 45.65 W. M. T.	

Minimum +7546, — 1859, March 30.

Watch Time.	Comparison.		
	δ	ϱ	*
^h ^m 8 12	δ 1 $\frac{1}{2}$ β	β 1 $\frac{1}{2}$ ϱ	β 1 $\frac{1}{2}$ *
18	2	1	1
24	2	1	1
30	2 $\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
36	3	$\frac{1}{2}$	$\frac{1}{2}$
42	3	=	=
48	3	=	=
8 54	3	=	=
9 0	3	=	=
6	3	$\frac{1}{2}$	=
12	2 $\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
18	2 $\frac{1}{2}$	1	1
24	2	1	1
30	2	1 $\frac{1}{2}$	1 $\frac{1}{2}$
9 36	δ 1 $\frac{1}{2}$ β	β 1 $\frac{1}{2}$ ϱ	β 1 $\frac{1}{2}$ *

Observed Time of Minimum.

By comparison with δ : —	with ϱ : —	with * : —
^h ^m 8 52.88	^h ^m 8 51.37	^h ^m 8 52.50
(weight, 3.)	(weight, 6.)	(weight, 1.)
Final mean,	^h ^m 8 51.94	
Correction for Watch-error,	—0.67	
	8 51.27	
Long. E. from Washington,	26.65	
Observed Minimum, March 30,	8 24.62 W. M. T.	

LETTER FROM MR. MASTERMAN TO THE EDITOR.

Weld, Franklin County, Maine, 1859, July 11.

I HAVE observed a few maxima of variables of long periods ;
the resulting times of some of which are annexed.

α <i>Cassiopeæ</i> ,	1858, December	22.28.
13 <i>Lyræ</i> ,	1858, December	12.89.
13 <i>Lyræ</i> ,	1859, June	4.74

 α *Herculis*, 1859, June 18.70

The last named was about equal to β *Ophiuchi* in brightness, at its maximum. I could scarcely perceive γ *Cygni*, with my naked eye, at the time of its expected maximum.

STILLMAN MASTERMAN.

NEW WORKS.

1. *Ueber die Verbesserung der Planeten-Elemente aus beobachteten Oppositionen. angewandt auf eine neue Bestimmung der Pallas-Bahn.* Von Dr. J. G. GALLE, ordentlichem Professor der Astronomie an der Universität zu Breslau. 1858. pp. 18.

A thorough and refined investigation of the true orbit of *Pallas* from twelve oppositions, from 1816 to 1855 inclusive, presented with all needed detail. The resulting values of the elements are regarded by Professor GALLE as affording as close

an accordance with observation for a long time to come, as can be obtained without reference to the perturbations by *Saturn*.

2. *Neue Folge der Mittleren Oerter von Fixsternen, für den Anfang von 1850. Abgeleitet aus den Beobachtungen auf der Hamburger Sternwarte.* Von CARL RÜMKE. Hamburg. 1859.

Professor Rümker, in this new issue, adds to his second catalogue the places of nearly three hundred stars between 6^h and

7^h of right-ascension, and gives a welcome token that his health has not yet been so seriously impaired, either by advancing years or insidious disease, as to arrest his astronomical labors.

3. *Radcliffe Observations for 1857.* Oxford. 1859.

This valued annual, issued with its accustomed promptness of reduction and publication, brings with its rich store of observations the sad remembrance that it is the last of its series over which the lamented and much-loved JOHNSON watched, — the last volume but one of the noble series of observations made under his superintendence and plans. Yet in the completion not only of the observations from which both his magnificent

Catalogue of Circumpolar Stars and the smaller "Catalogue of Remarkable Objects" are constructed, but also of the Catalogue itself in finished form, Mr. JOHNSON'S imperishable monuments were reared, and his admirable work accomplished. His own hands revised, and his own eye criticised, both the volume before us and the long desired Radcliffe Catalogue, and all that remains before the latter shall be given to the world is the mechanical execution of the type-setter and the pressman. The observations of the year 1858, now in process of reduction and preparation, will form the nineteenth volume of Radcliffe Observations, — the whole series constituting a memorial of which not only the countrymen of Johnson, but all who loved and honored him, may well be proud.

G.

PROSPECTUS.

A MANUAL OF SPHERICAL AND PRACTICAL ASTRONOMY, embracing *Nautical Astronomy and the Theory and Use of Fixed and Portable Astronomical Instruments.* By Professor WILLIAM CHAUVENET. In two royal-octavo volumes. Price \$ 7.50. Philadelphia: J. B. Lippincott & Co.

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The manuscript is already prepared, and it is proposed to commence the printing as soon as a sufficient number of subscriptions are received to warrant the undertaking. Those desiring the work are invited to send their names to the publishers at an early date.

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PROSPECTUS.

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THE ASTRONOMICAL JOURNAL.

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VOL. VI.

CAMBRIDGE, 1859, SEPTEMBER 15.

NO. 7.

OBSERVATIONS OF THE SECOND COMET OF 1859, OF EUTERPE, MELPOMENE,
PSYCHE, AND OF THE ECLIPSE OF THE SUN, 1859, JULY 29.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — Observations of the Comet and Asteroids corrected for refraction.]

COMET 1859 II.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$\Delta \alpha$	$\Delta \delta$	α	δ
	^h ^m ^s			^m ^s		^h ^m ^s	[°] ['] ["]
1859, May 12	9 13 46.2	13	1863 B. A. C.	+0 36.56	+5' 22.90	5 45 5.28	+27° 39' 59.79
13	8 47 35.2	10	* Anon.	+0 4.41	+6 37.89	5 42.2	+25 49

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
1863 B. A. C.	4	5 41 31.77	+27° 34' 29.80	} British Association Catalogue.
Anon.	9	5 42.1	+25 43.0	

EUTERPE.

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta \alpha$	$\Delta \delta$	α	δ
	^h ^m ^s			^m ^s		^h ^m ^s	[°] ['] ["]
1859, June 18	9 42 53.3	12	A. C. 16897	—0 26.28	+ 8' 50.39	17 23 1.57	—22° 44' 40.47
18	9 39 46.4	3	Anon.	—2 32.07	+11 4.39		
27	9 25 10.5	10	A. C. 16659	+0 29.60	— 3 58.14	17 13 51.43	22 40 23.70
27	9 25 10.5	10	" 16680	—0 19.33	— 6 39.54	17 13 51.53	22 40 20.32
30	9 21 10.4	15	" 16586	+0 33.07	— 5 27.29	17 11 1.33	—22 38 48.52

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
A. C. 16897	9	17 23 27.64	—22° 53' 23.00	} Argelander's Catalogue.
Anon.	8	17 25 33.30	22 55 37.80	
A. C. 16659	9	17 13 21.58	22 36 17.14	} Argelander's Catalogue.
" 16680	8.9	17 10 27.98	22 33 12.16	
" 16586	9	17 14 10.81	—22 33 32.49	

MELPOMENE.

Date.	Washington M. T.	No. of Comp.	Comparison Star.	$\Delta \alpha$ ⁽¹⁸⁾ — *	$\Delta \delta$	α ⁽¹⁸⁾ 's apparent	δ
1859, July	^h ^m ^s 5 10 55 41.4	21	B. A. C. 6361	+0 35.16	+ 2 50.76	18 35 12.01	—9 8 12.23
	8 9 20 20.4	18	Weisse, XVIII. 793	—0 30.77	— 6 12.31	18 32 11.46	9 22 10.64
	8 9 14 37.1	3	B. A. C. 6361	—2 25.50	—11 5.29	18 32 11.37	9 22 8.11
	9 9 17 9.0	15	Weisse, XVIII. 793	—1 32.42	—11 21.07	18 31 9.81	9 27 19.32
	9 9 10 6.08	2	B. A. C. 6361	—3 27.27	—16 11.50	18 31 9.62	—9 27 14.14

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
B. A. C. 6361	6	^h ^m ^s 18 34 36.57	— 9 10 57.85	B. A. C. Catalogue.
Weisse, XVIII. 793	8.9	18 32 41.72	— 9 15 52.71	Weisse's Catalogue.

PSYCHE.

Date.	Washington M. T.	No. of Comp.	Comparison Star.	$\Delta \alpha$ ⁽¹⁶⁾ — *	$\Delta \delta$	α ⁽¹⁶⁾ 's apparent	δ
1859, July	^h ^m ^s 20 10 54 20.1	13	A. C. 20423	+0 42.41	— 8 9.30	20 13 40.32	—17 24 14.55
	23 9 57 7.7	10	" 20366	+2 0.19	—10 27.83	20 11 11.00	17 34 50.47
	23 9 35 46.8	20	" 20366	+0 18.98	—17 40.85	20 9 29.72	—17 42 3.40

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
A. C. 20423	8	^h ^m ^s 20 12 57.22	—17 16 1.48	} Argelander's Catalogue.
A. C. 20366	7.8	20 9 10.03	—17 24 18.90	

ECLIPSE OF THE SUN.

M. T. Washington.

First Contact, ^h ^m ^s
5 22 23.71Cusps, 5 56 35.98 { 50° 43' Angle of Position of the chord.
14' 38".90 Distance.

Last Contact, 6 13 47.18

The day had been clear and serene, with occasional light entirely free from clouds. From 5^h 39^m to 5^h 54^m the sun clouds. The phases given above were satisfactorily observed, was entirely obscured. The barometer stood at 30ⁱⁿ.150, and a the part of the heavens in which the sun then was being thermometer in the shade at 86° F. The power used was 220.

ON THE THEORY OF THE COMET'S TAIL.

By BENJAMIN PEIRCE,

PERKINS PROFESSOR OF MATHEMATICS AND ASTRONOMY IN HARVARD UNIVERSITY.

(Continued from No. 120.)

SINCE the publication of the commencement of this article, and TOOMER have also expressed their observations numerically in right-ascension and declination, and all the observations of the front edge of the tail are now incorporated into the following table.

No. of Obs.	Date, 1858, Wash. M. T.	α	δ	Place.	No. of Obs.	Date, 1858, Wash. M. T.	α	δ	Place.
1	Sept. 28.067	193° 21'	39° 5'	Altona.	22	Oct. 6.310	225° 20'	35° 0'	Albany.
2	28.067	190 13	46 13	"	23	8.078	232 10	25 26	Altona.
3	Oct. 1.109	202 28	37 55	"	24	8.078	235 54	42 51	"
4	1.109	199 36	50 26	"	25	8.275	228 27	16 40	Albany.
5	2.060	205 42	39 16	"	26	8.275	230 35	20 40	"
6	2.060	202 46	49 41	"	27	9.047	244 8	52 57	Altona.
7	2.310	205 5	28 45	Albany.	28	9.333	230 0	10 0	Albany.
8	2.310	206 0	31 0	"	29	9.333	235 35	18 35	"
9	2.310	207 0	35 0	"	30	9.333	239 30	27 30	"
10	2.310	207 15	40 0	"	31	10.078	240 12	17 27	Altona.
11	2.310	206 50	46 15	"	32	10.290	229 45	3 20	Albany.
12	4.105	215 2	36 10	Altona.	33	10.290	234 0	7 5	"
13	4.105	213 55	46 38	"	34	10.290	234 45	8 0	"
14	5.092	219 26	35 55	"	35	10.290	239 15	13 50	"
15	5.092	217 55	50 25	"	36	10.290	241 21	16 55	"
16	5.310	215 40	23 0	Albany.	37	10.290	243 24	19 46	"
17	5.310	218 25	29 20	"	38	10.290	244 40	21 38	"
18	5.310	221 0	38 30	"	39	12.067	250 45	13 30	Altona.
19	6.085	223 21	28 55	Altona.	40	12.067	245 58	5 47	"
20	6.085	224 29	48 26	"	41	15.290	245 25	—13 50	Albany.
21	6.310	221 30	24 30	Albany.	42	15.290	259 42	— 6 5	"

All these observations were made with the naked eye. PAPE estimates the uncertainty of his own observations to be more, rather than less, than a quarter of a degree; and the observations at the Dudley Observatory seem to be of just about the same degree of accuracy, as it may be inferred from the comparison of the observations of Messrs. SEARLE and TOOMER.

In order to obtain a final approximation to the value of μ , which might serve as a basis for subsequent computation, a preliminary investigation was made of the form of tail which would correspond to different values of μ upon the dates of Oct. 2.310, and Oct. 5.310. The following points of the tail were determined for the three different values of μ .

$$\mu = -2, \quad = -1\frac{1}{2}, \quad = -1.$$

For Oct. 2.					
$\mu = -2$		$\mu = -1\frac{1}{2}$		$\mu = -1$	
α	δ	α	δ	α	δ
206° 7'	31° 34'	205° 33'	31° 18'	205° 18'	29° 34'
207 21	36 31	206 43	35 32	206 10	33 1
209 21	42 41	207 31	41 0	206 57	37 37
207 59	49 20	207 18	47 7	206 46	43 5
For Oct. 5.					
213 4	19 58	214 38	21 41		
219 40	30 35	218 24	29 24		
222 1	37 34	220 27	35 24		
223 46	45 13	221 54	42 29		

When the different tails are drawn from these data, it is apparent that nice observations are required to determine the value of μ with any great precision. It will be seen, however, that the value of $\mu = -1\frac{1}{2}$ corresponds so nearly to that of

the observations as to render it expedient to adopt this value as the basis of the computations; and the curves of the front edge can be computed for the various dates of observation, as in the following table.

Date of Particles' leaving the Comet.	For Sept. 28.067		For Oct. 1.109		For Oct. 2.310	
	α	δ	α	δ	α	δ
Sept. 11.729	192° 15'	45° 45'	201° 42'	49° 21'	205° 9'	50° 47'
11.736	192 51	42 47	202 39	45 53	207 18	47 7
18.684	193 2	38 28	202 52	40 15	207 31	41 0
21.930	192 48	35 14	202 13	35 26	206 43	35 32
21.736	192 30	33 15	201 28	31 52	205 33	31 18
29.736					203 56	26 44

Date of Particles' leaving the Comet.	For Oct. 4.105		For Oct. 5.310		For Oct. 6.310	
	α	δ	α	δ	α	δ
Sept. 14.736	215 32	48 52	221 36	49 50	227 10	50 27
18.684	215 46	42 0	221 54	42 29	227 28	42 42
21.930	214 36	35 33	220 27	35 24	225 47	35 6
24.736	212 58	30 16	218 24	29 24	223 23	28 35
29.736	210 7	23 49	214 38	21 41	218 45	19 44
Oct. 2.310			213 24	19 5		
	For Oct. 8.275		For Oct. 9.047		For Oct. 9.333	
Sept. 14.736	239 5	51 0	243 45	50 54	245 14	50 51
18.684	239 28	42 26	241 8	42 3	245 39	41 53
21.930	237 22	33 51	241 57	33 6	243 24	32 51
24.736	234 14	26 11	238 35	25 4	239 59	24 42
29.736	227 46	15 23	231 27	13 33	232 38	12 58
Oct. 2.310	224 57	12 10			229 31	9 12
4.105	223 11	10 26			227 1	7 21
	For Oct. 10.290		For Oct. 12.067		For Oct. 15.290	
Sept. 21.930	249 28	31 37				
24.736	245 49	23 0	255 54	19 23		
29.736	237 40	10 26	246 50	5 45	262 54	— 2 15
Oct. 2.310	232 49	7 19			257 14	— 7 37
4.105	231 0	4 12	238 25	—1 28	252 15	—10 56
6.310					249 26	—12 19
7.543					247 31	—13 2
10.789					243 52	—13 57
14.736					242 8	—14 5

The comparison of these curves of the front edge of the tail with the preceding observations may be made with sufficient accuracy by means of diagrams, from which the following approximate distances of the places given by observation from the corresponding curves have been obtained.

No. of Obs.	Observation in advance of Computed Curve.	No. of Obs.	Observation in advance of Computed Curve.	No. of Obs.	Observation in advance of Computed Curve.	No. of Obs.	Observation in advance of Computed Curve.	No. of Obs.	Observation in advance of Computed Curve.	No. of Obs.	Observation in advance of Computed Curve.
1	+10	8	+10	15	—70	22	—25	29	—38	36	—40
2	—60	9	+10	16	+ 5	23	+ 5	30	—60	37	—30
3	+ 8	10	0	17	0	24	—65	31	—10	38	—15
4	—45	11	—15	18	0	25	0	32	+ 5	39	—40
5	0	12	0	19	+50	26	—10	33	0	40	—30
6	—50	13	—80	20	—40	27	+30	34	— 5	41	0
7	+10	14	0	21	0	28	0	35	—30	42	+15

The agreement between the observations and the computed forms seems to be all that can be expected from such a difficult class of observations, and is at least as close as that which PAPE regards as sufficient in the comparison with his own theory. There is therefore no necessity for the introduction of the element of the velocity derived by the particles from the action of the nucleus at the time of its separation, and no indication in the observed curvature of the tail that there is any sensible velocity obtained from this source. It may be justly inferred that this velocity is quite small, and that the theory which is here adopted is essentially correct. It is, generally, apparent that the observed tail falls behind the computed one, and especially towards its extremity, which is naturally to be expected as an optical phenomenon, from the greater liability to obscuration in the vicinity of the edge. But there are enough positive observations to satisfy one that the computed curve is not really in advance of the front edge of the tail, and they rather incline to the belief of the contrary defect. However this may be, there seems to be no sufficient reason from the observations for any change in the value of μ from that which was adopted in the first approximation. If, then, the present theory is admitted to be a close approximation to the truth, it can be used as a means of bringing together the observations of different dates, and combining those which are a few days apart into one curve for some intermediate instant, and this curve may be called *the normal front edge of the tail for the instant*.

To form the normal curves, each observed particle of the tail may be supposed to move along its actual path in conformity with the present theory, until it arrives at a point which is just as far advanced in time beyond the computed curve for the normal date, as at the instant of observation it was in advance of the computed curve of that date. For all the purposes of investigation, it will be just as exact, and more convenient, to place the curve in the plane of the orbit, and express it by means of rectangular coördinates. The sun may then be assumed as the origin of coördinates, the axis of x may be the line of apsides of the curve, and the axis of y the perpendicular to the line of apsides. The dates of the normal tails may be assumed as Oct. 2.290, Oct. 9.290, and Oct. 15.290, and the first eighteen observations, from Sept. 28 to Oct. 5, may be reduced to the first date; the observations 19 to 40 inclusive, from Oct. 6 to Oct. 12, may be included in the

second date, while the third normal date will only include the two observations of that date.

The following are the coördinates of the normal tails, with the corresponding velocities of the particles of the tail in the directions of the axes, which are respectively denoted by x' and y' .

The values of x , y , x' , and y' are denoted by the formulas,

$$x = r \cos \varphi$$

$$y = r \sin \varphi$$

$$\cot \varepsilon = \cot \eta \sin \psi$$

$$v = \frac{k \sqrt{2 \mu}}{r \sin \varepsilon}$$

$$x' = v \cos (\varphi + \varepsilon)$$

$$y' = v \sin (\varphi + \varepsilon)$$

Computed Tail of the Comet on October 2.290.

Date of Particles' leaving Comet.	x	y	x'	y'	Date of Particles' leaving Comet.	x	y	x'	y'
Oct. 2.2900	.5756	.0815	— .0025	.0318	Sept. 23.5652	.6540	.0671	.0156	.0299
2.0772	.5757	.0815	.0020	.0319	23.3524	.6575	.0658	.0160	.0297
1.8644	.5759	.0815	.0015	.0319	23.1396	.6610	.0644	.0164	.0295
1.6516	.5762	.0815	.0010	.0320	22.9268	.6646	.0630	.0167	.0294
1.4388	.5765	.0816	— .0005	.0320	22.7110	.6682	.0615	.0171	.0292
1.2260	.5769	.0816	.0000	.0321	22.5012	.6719	.0599	.0174	.0290
1.0132	.5774	.0816	.0005	.0321	22.2884	.6756	.0582	.0178	.0289
Sept. 30.8004	.5781	.0816	.0010	.0321	22.0756	.6794	.0565	.0181	.0287
30.5876	.5789	.0817	.0015	.0321	21.8628	.6832	.0546	.0184	.0285
30.3748	.5798	.0817	.0020	.0321	21.6500	.6870	.0526	.0187	.0283
30.1620	.5807	.0817	.0024	.0322	21.4372	.6909	.0506	.0190	.0282
29.9492	.5817	.0818	.0029	.0322	21.2244	.6948	.0485	.0193	.0280
29.7364	.5828	.0818	.0034	.0322	21.0116	.6987	.0461	.0196	.0278
29.5236	.5840	.0818	— .0039	.0322	20.7988	.7026	.0442	.0199	.0276
29.3108	.5854	.0817	.0043	.0322	20.5860	.7066	.0420	.0202	.0274
29.0980	.5869	.0817	.0048	.0322	20.3732	.7105	.0398	.0204	.0272
28.8852	.5884	.0816	.0053	.0321	20.1604	.7145	.0375	.0207	.0270
28.6724	.5900	.0816	.0057	.0321	19.9476	.7184	.0352	.0210	.0268
28.4596	.5917	.0815	.0062	.0321	19.7348	.7221	.0328	.0212	.0266
28.2468	.5935	.0814	.0067	.0321	19.5220	.7264	.0303	.0215	.0264
28.0340	.5954	.0813	.0071	.0320	19.3092	.7304	.0277	.0217	.0262
27.8212	.5974	.0811	.0076	.0320	19.0964	.7344	.0250	.0220	.0260
27.6084	.5995	.0809	.0080	.0319	18.8836	.7385	.0222	.0222	.0258
27.3956	.6017	.0806	.0085	.0319	18.6708	.7425	.0193	.0224	.0255
27.1828	.6040	.0802	.0087	.0318	18.4580	.7465	.0163	.0227	.0253
26.9700	.6063	.0798	.0093	.0317	18.2452	.7505	.0133	.0229	.0251
26.7572	.6087	.0794	.0097	.0316	18.0324	.7545	.0102	.0231	.0249
26.5444	.6112	.0789	.0102	.0316	17.8196	.7585	.0071	.0233	.0246
26.3316	.6138	.0784	.0106	.0315	17.6068	.7625	.0039	.0235	.0244
26.1188	.6165	.0779	.0110	.0314	17.3940	.7664	— .0007	.0237	.0242
25.9060	.6193	.0773	.0114	.0313	17.1812	.7704	.0026	.0239	.0239
25.6932	.6221	.0766	.0118	.0312	16.9684	.7744	.0060	.0241	.0237
25.4804	.6250	.0759	.0122	.0311	16.7556	.7783	.0095	.0243	.0235
25.2676	.6280	.0751	.0126	.0310	16.5428	.7823	.0130	.0245	.0232
25.0548	.6311	.0743	.0130	.0308	16.3300	.7862	.0166	.0247	.0230
24.8420	.6342	.0735	.0134	.0307	16.1172	.7901	.0202	.0248	.0228
24.6292	.6371	.0726	.0139	.0306	15.9044	.7939	.0239	.0250	.0225
24.4164	.6406	.0716	.0142	.0305	15.6916	.7978	.0277	.0252	.0223
24.2036	.6439	.0706	.0145	.0303	15.4788	.8017	.0316	.0254	.0221
23.9908	.6472	.0695	.0149	.0302	15.2660	.8055	.0355	.0255	.0218
23.7780	.6506	.0683	.0153	.0300	15.0532	.8093	— .0395	.0257	.0216

Date of Particles' leaving Comet.	x	y	x'	y'	Date of Particles' leaving Comet.	x	y	x'	y'
Sept. 14.8404	.8131	— .0435	.0258	.0243	Sept. 11.2228	.8719	— .1187	.0278	.0173
14.6276	.8169	.0475	.0260	.0211	11.0100	.8751	.1235	.0279	.0171
14.4148	.8206	.0516	.0261	.0208	10.7972	.8782	.1283	.0279	.0169
14.2020	.8243	.0557	.0262	.0206	10.5844	.8813	.1332	.0280	.0167
13.9892	.8279	.0598	.0264	.0203	10.3716	.8843	.1381	.0281	.0165
13.7761	.8315	.0640	.0265	.0201	10.1588	.8873	.1431	.0281	.0163
13.5636	.8351	.0683	.0265	.0199	9.9460	.8902	.1481	.0282	.0160
13.3508	.8386	.0727	.0268	.0196	9.7332	.8931	.1531	.0283	.0158
13.1380	.8421	.0771	.0269	.0194	9.5204	.8959	.1581	.0283	.0156
12.9252	.8456	.0815	.0270	.0192	9.3076	.8987	.1631	.0284	.0154
12.7121	.8490	.0860	.0271	.0189	9.0948	.9015	.1682	.0285	.0152
12.4996	.8524	.0905	.0272	.0187	8.8820	.9042	.1733	.0285	.0150
12.2868	.8557	.0951	.0273	.0185	8.6692	.9069	.1784	.0286	.0148
12.0740	.8590	.0997	.0274	.0182	8.4564	.9096	.1836	.0286	.0146
11.8612	.8623	.1044	.0275	.0180	8.2436	.9122	.1888	.0287	.0144
11.6484	.8655	.1091	.0276	.0178	8.0308	.9148	— .1940	.0287	.0142
11.4356	.8687	— .1139	.0277	.0176					

Computed Tail of October 9.290.

Date of Particles' leaving Comet.	x	y	x'	y'	Date of Particles' leaving Comet.	x	y	x'	y'
Oct. 9.2900	.5399	.2989	— .0090	.0290	Sept. 30.5876	.6171	.3145	.0090	.0316
8.6740	.5101	.2992	.0067	.0305	30.3748	.6211	.3146	.0095	.0346
8.4612	.5104	.2994	.0063	.0307	30.1620	.6251	.3146	.0099	.0345
8.2481	.5108	.2996	.0059	.0309	29.9492	.6295	.3146	.0103	.0345
8.0356	.5112	.2998	.0055	.0311	29.7364	.6338	.3145	.0107	.0345
7.8228	.5118	.3000	.0052	.0312	29.5236	.6381	.3144	.0111	.0345
7.6100	.5124	.3002	.0048	.0314	29.3108	.6425	.3142	.0115	.0344
7.3972	.5131	.3005	.0044	.0316	29.0980	.6469	.3140	.0119	.0344
7.1844	.5139	.3008	.0040	.0318	28.8852	.6514	.3137	.0123	.0343
6.9716	.5148	.3012	.0036	.0319	28.6724	.6560	.3133	.0127	.0343
6.7588	.5158	.3016	.0032	.0321	28.4596	.6608	.3128	.0131	.0342
6.5460	.5169	.3020	.0028	.0323	28.2468	.6656	.3123	.0135	.0341
6.3332	.5181	.3024	.0024	.0324	28.0340	.6705	.3117	.0139	.0340
6.1204	.5193	.3029	.0020	.0326	27.8212	.6754	.3111	.0143	.0340
5.9076	.5206	.3034	.0016	.0327	27.6084	.6804	.3104	.0146	.0339
5.6948	.5220	.3039	.0012	.0329	27.3956	.6854	.3096	.0150	.0338
5.4820	.5236	.3044	.0008	.0330	27.1828	.6905	.3087	.0154	.0337
5.2692	.5253	.3049	— .0003	.0331	26.9700	.6957	.3077	.0158	.0336
5.0564	.5271	.3054	.0001	.0333	26.7572	.7010	.3067	.0161	.0335
4.8436	.5289	.3059	.0005	.0334	26.5444	.7063	.3056	.0165	.0334
4.6308	.5308	.3064	.0007	.0335	26.3316	.7117	.3044	.0169	.0332
4.4180	.5329	.3070	.0014	.0336	26.1188	.7171	.3031	.0172	.0331
4.2052	.5351	.3076	.0018	.0337	25.9060	.7227	.3017	.0176	.0330
3.9924	.5374	.3081	.0022	.0338	25.6932	.7280	.3002	.0179	.0329
3.7796	.5398	.3087	.0027	.0339	25.4804	.7335	.2986	.0183	.0327
3.5668	.5422	.3092	.0031	.0340	25.2676	.7391	.2970	.0186	.0326
3.3540	.5447	.3097	.0035	.0341	25.0548	.7447	.2952	.0189	.0324
3.1412	.5474	.3102	.0039	.0341	24.8420	.7503	.2934	.0193	.0323
2.9284	.5502	.3107	.0043	.0342	24.6292	.7560	.2915	.0196	.0321
2.7156	.5531	.3112	.0048	.0343	24.4164	.7617	.2894	.0199	.0319
2.5028	.5561	.3117	.0052	.0343	24.2036	.7674	.2873	.0202	.0317
2.2900	.5592	.3121	.0056	.0344	23.9908	.7731	.2851	.0206	.0316
2.0772	.5624	.3125	.0060	.0344	23.7780	.7788	.2828	.0209	.0314
1.8644	.5657	.3129	.0065	.0345	23.5652	.7846	.2804	.0212	.0312
1.6516	.5691	.3132	.0068	.0345	23.3524	.7904	.2779	.0215	.0310
1.4388	.5726	.3135	.0073	.0345	23.1396	.7962	.2753	.0218	.0308
1.2260	.5762	.3138	.0078	.0346	22.9268	.8020	.2726	.0221	.0306
1.0132	.5808	.3141	.0082	.0346	22.7140	.8079	.2698	.0224	.0304
Sept. 30.8004	.6135	.3143	.0086	.0346	22.5012	.8137	.2669	.0226	.0302

Date of Particles' leaving Comet.	x	y	x'	y'	Date of Particles' leaving Comet.	x	y	x'	y'
Sept. 22.2884	.8195	.2639	.0229	.0300	Sept. 18.2152	.9275	.1901	.0273	.0256
22.0756	.8253	.2608	.0232	.0298	18.0324	.9329	.1854	.0275	.0253
21.8628	.8311	.2577	.0235	.0296	17.8196	.9383	.1806	.0276	.0251
21.6500	.8369	.2545	.0238	.0294	17.6068	.9436	.1757	.0278	.0248
21.4372	.8427	.2512	.0240	.0292	17.3940	.9489	.1708	.0280	.0245
21.2244	.8485	.2477	.0243	.0289	17.1812	.9542	.1658	.0281	.0243
21.0116	.8543	.2441	.0245	.0287	16.9684	.9594	.1607	.0283	.0240
20.7988	.8601	.2404	.0247	.0285	16.7556	.9645	.1555	.0285	.0238
20.5860	.8659	.2367	.0249	.0283	16.5428	.9696	.1503	.0286	.0235
20.3732	.8716	.2329	.0252	.0280	16.3300	.9747	.1450	.0288	.0233
20.1604	.8773	.2290	.0254	.0278	16.1172	.9797	.1397	.0289	.0230
19.9476	.8830	.2250	.0256	.0276	15.9044	.9847	.1343	.0291	.0228
19.7348	.8887	.2209	.0259	.0273	15.6916	.9896	.1288	.0292	.0225
19.5220	.8943	.2168	.0261	.0271	15.4788	.9945	.1233	.0293	.0223
19.3092	.8999	.2126	.0263	.0269	15.2660	.9993	.1177	.0294	.0220
19.0964	.9055	.2083	.0265	.0266	15.0532	1.0040	.1120	.0296	.0218
18.8836	.9110	.2038	.0267	.0264	14.8404	1.0087	.1063	.0297	.0215
18.6708	.9165	.1993	.0269	.0261	14.6276	1.0133	.1005	.0298	.0213
18.4580	.9220	.1947	.0271	.0259	14.4148	1.0178	.0946	.0299	.0210

Computed Tail of October 15.290.

Date of Particles' leaving Comet.	x	y	x'	y'	Date of Particles' leaving Comet.	x	y	x'	y'
Oct. 15.2900	.4825	.4711	— .0109	.0277	Oct. 7.3972	.5325	.5009	.0005	.0351
15.0580	.4825	.4714	.0109	.0277	7.1844	.5356	.5022	.0009	.0352
14.8452	.4826	.4715	.0106	.0279	6.9716	.5388	.5035	.0012	.0354
14.6324	.4827	.4716	.0104	.0282	6.7588	.5421	.5048	.0016	.0355
14.4196	.4829	.4718	.0101	.0284	6.5460	.5456	.5061	.0020	.0357
14.2068	.4832	.4720	.0098	.0286	6.3332	.5491	.5074	.0023	.0358
13.9940	.4835	.4723	.0096	.0289	6.1204	.5527	.5086	.0027	.0359
13.7812	.4839	.4726	.0093	.0291	5.9076	.5565	.5099	.0031	.0360
13.5684	.4843	.4730	.0090	.0294	5.6948	.5603	.5111	.0035	.0361
13.3556	.4848	.4734	.0087	.0296	5.4820	.5642	.5123	.0038	.0362
13.1428	.4854	.4739	.0085	.0298	5.2692	.5683	.5135	.0042	.0363
12.9300	.4861	.4744	.0082	.0300	5.0564	.5725	.5147	.0046	.0364
12.7172	.4868	.4750	.0079	.0303	4.8436	.5767	.5159	.0050	.0365
12.5044	.4876	.4756	.0076	.0305	4.6308	.5811	.5170	.0054	.0366
12.2916	.4885	.4763	.0073	.0307	4.4180	.5856	.5181	.0058	.0367
12.0788	.4894	.4770	.0070	.0310	4.2052	.5902	.5192	.0062	.0367
11.8660	.4904	.4778	.0067	.0312	3.9924	.5949	.5202	.0066	.0368
11.6532	.4915	.4786	.0064	.0314	3.7796	.5997	.5212	.0070	.0368
11.4404	.4927	.4794	.0061	.0316	3.5668	.6046	.5222	.0074	.0369
11.2276	.4940	.4803	.0058	.0318	3.3540	.6097	.5231	.0078	.0369
11.0148	.4954	.4812	.0055	.0320	3.1412	.6148	.5240	.0082	.0370
10.8020	.4968	.4822	.0051	.0322	2.9284	.6200	.5249	.0086	.0370
10.5892	.4983	.4832	.0048	.0324	2.7156	.6254	.5256	.0089	.0370
10.3764	.4999	.4842	.0045	.0326	2.5028	.6308	.5262	.0093	.0371
10.1636	.5016	.4852	.0041	.0329	2.2900	.6363	.5268	.0097	.0371
9.9508	.5034	.4863	.0038	.0331	2.0772	.6420	.5273	.0101	.0371
9.7380	.5054	.4874	.0035	.0333	1.8644	.6477	.5278	.0105	.0371
9.5252	.5074	.4885	.0031	.0335	1.6516	.6535	.5282	.0109	.0371
9.3124	.5095	.4897	.0028	.0337	1.4388	.6594	.5285	.0112	.0370
9.0996	.5116	.4908	.0024	.0339	1.2260	.6654	.5288	.0116	.0370
8.8868	.5138	.4920	.0021	.0340	1.0132	.6715	.5290	.0120	.0370
8.6740	.5161	.4933	.0017	.0342	Sept. 30.8001	.6777	.5291	.0124	.0369
8.4612	.5186	.4945	.0013	.0344	30.5875	.6840	.5291	.0128	.0369
8.2484	.5212	.4958	.0010	.0346	30.3748	.6903	.5290	.0132	.0368
8.0356	.5238	.4971	.0006	.0347	30.1620	.6967	.5289	.0135	.0368
7.8228	.5266	.4984	— .0002	.0349	29.9492	.7032	.5287	.0139	.0367
7.6100	.5295	.4996	.0001	.0350	29.7364	.7098	.5283	.0143	.0367

The computations for these curves were made for every sixth date, and the intermediate numbers were derived by interpolation. By referring to these computed curves the different observations, in the manner already indicated, they are expressed in numbers in the following way.

For October 2.290.								
Number of Observation.	<i>x</i>	<i>y</i>	Number of Observation.	<i>x</i>	<i>y</i>	Number of Observation.	<i>x</i>	<i>y</i>
1	.7512	.0141	7	.6090	.0805	13	.7894	— .0351
2	.8626	— .1241	8	.6346	.0745	14	.6832	.0546
3	.7100	.0390	9	.6688	.0625	15	.8178	— .0609
4	.8773	— .1423	10	.7304	.0277	16	.6223	.0771
5	.7224	.0328	11	.8043	— .0367	17	.6342	.0735
6	.8466	— .1013	12	.6909	.0506	18	.7505	.0133
For October 9.290.								
19	.6408	.3233	27	1.0208	.0967	34	.5673	.3059
20	.9823	.1232	28	.5674	.3081	35	.5950	.3091
21	.6098	.3141	29	.5884	.3072	36	.6088	.3098
22	.8214	.2558	30	.6659	.3004	37	.6165	.3110
23	.6299	.3163	31	.5951	.3095	38	.6286	.3117
24	.9111	.1941	32	.5409	.3017	39	.6269	.3057
25	.5747	.3097	33	.5506	.3012	40	.5886	.3087
26	.6090	.3106						
For October 15.290.								
41	.5034	.4863	42	.5951	.5214			

(To be continued.)

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ON THE THEORY OF THE COMET'S TAIL, BY PROFESSOR BENJAMIN PEIRCE.

ADVERTISEMENT.

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CAMBRIDGE, 1859, OCTOBER 7.

NO. 8.

OCCULTATIONS OF THE PLEIADES.

LETTER FROM PROFESSOR BACHE TO THE EDITOR.

Coast Survey Station, near Cooper, Maine, 1859, August 24.

I HAVE the honor to forward to you, for publication in the *Astronomical Journal*, Observations upon the Occultations of the *Pleiades*, from 1857, August 12, to 1858, November 20.

A. D. BACHE, *Supt.*

ABSTRACT OF NOTES OF OBSERVATIONS

MADE AT VARIOUS OBSERVATORIES, PUBLIC AND PRIVATE,

From 1857, August 12, to 1858, November 20.

[The numbers of the stars are BESSEL'S.]

1857, August 12.

ANN ARBOR OBSERVATORY, MICHIGAN.

Observer, J. C. WATSON.

Instrument, Equatorial.

Star.	No.	Sidereal Time.						Remarks.
		Immersion.			Emersion.			
		^h	^m	^s	^h	^m	^s	
<i>Merope</i>	17	21	36	51.0	22	8	35.4	Times corrected for error of chronometer.
	21	21	41	39.0				
	31	21	48	38.5	22	40	37.8	
<i>Alcyone</i>	34	22	15	57.6				
	40	22	19	2.7				
	43				23	19	42.2	
<i>Atlas</i>	41	22	30	35.9	23	27	34.7	
<i>Pleione</i>	42	22	37	35.5	23	28	52.6	
	46	22	54	45.8	23	32	25.5	
	50				23	40	18.6	
	48				23	44	18.4	
	49				23	49	32.7	

NOTE BY DR. F. BRÜNNOW. — "The error of the clock could not be found with sufficient accuracy, as the error of collimation was not well determined; the times, however, are believed to be correct within half a second."

1857, August 12.

GIBBES'S OBSERVATORY, CHARLESTON, S. C.

Observer, LEWIS R. GIBBES.

Instrument made by G. Adams, London; 5 feet focal length; power, 70; object-glass diameter, $3\frac{3}{4}$ inches.

Star.	No.	Mag.	Mean Time.						Remarks.		
			Immersion.			Emersion.					
			h	m	s		h	m	s		
<i>Merope</i>	17	5	12	4	27.	?	12	51	26.7	?	{ Imm. and Em. very uncertain. Imm., lost sight of star when near the limb; Em. good.
	27	7	12	35	27.	?	13	16	28.0		
<i>Alcyone</i>	34	3	12	36	9.5		13	20	54.0		Imm. and Em. good.
	40	7	12	59	26.7		13	38	21.0		{ Imm. very doubtful, atmosphere tremulous at disappearance; Em. good.
<i>Atlas</i>	41	4	13	4	17.5		14	2	3.5		{ Imm. good; Em. uncertain, perhaps 1 st .
<i>Pleione</i>	42	5	13	8	11.3		14	7	4.0		Imm. and Em. good.
	43	8					13	46	21.0		Good.
	44	8					14	4	20.5		Good.
	45	8	13	36	35.5		14	9	26.3		Not good.
	50	8					14	31	52.3		Not good.
	52	8					14	43	22.5		Good.

A light haze during first hour of observations rendered it

impossible to observe disappearances of stars of seventh, eighth, and ninth magnitudes, and the attempts to observe reappearances of stars of the ninth magnitude were also unsuccessful.

1857, August 12.

NEWPORT, FRANKLIN CO., MISSOURI.

Observer, D. W. GOEBEL.

Instrument, a Fraunhofer Achromatic, 30 inches focal length, $2\frac{5}{12}$ inches aperture ; power used, 60.

Star.	No.	Mean Time.						Remarks.
		Immersion.			Emersion.			
		h	m	s	h	m	s	
<i>Merope</i>	17	11	38	40.26	12	6	8.25	{ Imm., Moon in a thin mist; Em., Moon invisible.
<i>Atlas</i>	41	12	29	20.21	13	22	32.66	
								Good observation.

1857, October 6.

ST.-PETERSBURG OBSERVATORY.

Observer, Prof. SAWITSCH.

Star.	Mean Time.					
	Immersion.			Emersion.		
	h	m	s	h	m	s
23 d <i>Pleiadum (Merope)</i>	8	57	43.5	9	27	27.5
27 f <i>Pleiadum (Atlas)</i>	9	50	41.5			

1857, October 30.

ST.-PETERSBURG OBSERVATORY.

Observer, Prof. SAWITSCH.

Star.	Mean Time. — Immersion.		
	h	m	s
27 f <i>Pleiadum (Atlas)</i>	7	12	41.0
28 h <i>Pleiadum (Pleione)</i>	7	22	30.0

1857, November 2.

NEWPORT, FRANKLIN CO., MISSOURI.

Observer, D. W. GOEBEL.

Instrument, a Fraunhofer Achromatic, of 30 inches focal length, and $2\frac{5}{12}$ inches aperture ; power used, 60.

Star.	No.	Mean Time. — Immersion.			Remarks.
		h	m	s	
<i>Electra</i>	2	9	53	24.01	{ Very inconveniently observed, on account of the great altitude of the moon.
<i>Merope</i>	17	10	24	21.38	
<i>Alcyone</i>	34	10	59	30.22	

The observations were made in the house, under disadvantage, no portable chronometer being on hand ; the emersions were not observed on account of the projecting roof of the house. The air was very transparent, but so unsteady that the moon's limb appeared always in violent motion, which

rendered the true appreciation of the moment of immersion very uncertain ; and owing to this state of the air, and the brightness of the moon, stars smaller than the fifth magnitude could not be observed.

1857, November 2.

BURLINGTON, N. J.

Observer, SAMUEL J. GUMMERE.

Instrument, an Equatorial, by H. Fitz, of New York ; 5 feet focal length ; 4 inches aperture ; power used, 120.

Star.	No.	Mean Time. — Immersion.			Remarks.
		h	m	s	
<i>Electra</i>		11	15	44	The immersions were satisfactorily noted.
<i>Celæno</i>	1	11	30	54	
<i>Maia</i>	11	12	0	7.5	
<i>Alcyone</i>	34	12	42	30.5	

1857, November 2.

WILLIAMS COLLEGE OBSERVATORY, WILLIAMSTOWN, MASS.

Observer, C. J. LYONS,

Star.	No.	Sidereal Time. — Immersion.		
		h	m	s
<i>Electra</i>	2	2	17	53.5

The evening was cloudy, and the other stars were not observed.

1857, November 2.

NEWARK, N. J.

Observer, ROBERT VAN ARSDALE.

Instrument, Refractor, by Fitz of New York ; $8\frac{1}{2}$ feet focal length ; $6\frac{3}{8}$ inches aperture ; power used, 100.

Star.	No.	Sidereal Time. — Immersion.		
		h	m	s
<i>Electra</i>	2	2	9	51
<i>Celæno</i>	1	2	25	12
<i>Maia</i>	11	2	54	41
<i>Merope</i>	17	3	4	42
* ¹		3	35	51.5

The lesser stars of the group on their approach to the bright edge of the Moon were too indistinct for observation.

1857, November 2.

MILITARY ACADEMY, WEST POINT, N. Y.

Observer, W. H. C. BARTLETT.

Instruments : a 10-inch Refractor and a Sidereal Chronometer.

Star.	No.	Sidereal Time — Immersion.		
		h	m	s
<i>Electra</i>	2	2	12	3.6
<i>Maia</i>	11	2	57	39.6
<i>Alcyone</i>	34	3	36	15.8

¹ No number given.

1857, November 2.

DARTMOUTH COLLEGE, HANOVER, N. H.

Observer, IRA YOUNG.

Instrument: an Equatorial, by Merz and Sons of Munich;
9 feet focal length; aperture, 6.4 inches; power, 85.

Star.	No.	Sidereal Time.					
		Immersion.			Emersion.		
		h	m	s	h	m	s
<i>Electra</i>	2	2	24	23	3	36	30
<i>Merope</i>	17	3	10	38			
<i>Maia</i>	11	3	11	59			

The sky was overcast, and the stars observed appeared so faint that the precise moment of their contact with the bright limb of the moon could not be satisfactorily determined.

"As *Electra* disappeared behind a cloud within some eight or ten seconds after its apparent emersion, I am in doubt whether it really emerged from behind the moon, or through a chink in the cloud."

1857, November 2.

CHARLESTON, S. C.

Observer, LEWIS R. GIBBES.

Instrument, made by G. Adams, London; focal length, 5 feet;
diameter of object glass, $3\frac{3}{4}$ inches; power, 70.

Star.	No.	Mag.	Mean Time. — Emersions.			Remarks.
			h	m	s	
<i>Electra</i>	2	$4\frac{1}{2}$	11	51	7.5	Uncertain.
<i>Celano</i>	1	$5\frac{1}{2}$	11	56	57.0	Good.
<i>Taygeta</i>	4	5	12	5	49.3	Tolerably certain.

A thick haze, illuminated by a full moon, prevented all observation of disappearances, and permitted only a few reappearances to be seen, as the haze diminished.

1858, August 30.

ROYAL OBSERVATORY, BRUSSELS.

There were three Observers: ERNEST QUETELET, with the Troughton Equatorial, of between 3 and 4 inches aperture, Professor QUETELET, with a smaller, and M. HOOREMAN, with a larger instrument.

Star.	No.	Sidereal Time. — Immersion.						Sidereal Time. — Emersion.					
		Prof. Quetelet.			E. Quetelet.			Prof. Quetelet.			E. Quetelet.		
		h	m	s	s	s	s	h	m	s	s	s	s
<i>Celano</i>	1	0	6	54.6	55.3	54.1	0	46	5.1	6.3			
	3	0	51		40.7		1	11		7.1			
<i>Taygeta</i>	4	0	14	2.8	4.5	1.3	1	17		7.2			
	8						1	3		49.2			
<i>Maia</i>	11	0	39		35.7	35.0	1	13		36.6			
<i>Asterope</i>	13	0	34			58.4	1	41	7.1	7.8	6.1		
	14	0	38		47.8		1	41		58.8	57.3		
	20						1	59		52.0	52.8		
	29						2	18		13.7	13.8		
	30						2	28			2.4		

Weather tolerably favorable.

1857, November 30.

CHRISTIANIA, NORWAY.

Observer, Dr. M. FEARNLEY.

Star.	Christiania Mean Time.					
	Immersion.			Emersion.		
	h	m	s	h	m	s
<i>27 Tauri</i>	5	59	42.4	6	29	50.9

The emersion being oblique, the time here given may be a second too late.

1857, December 27.

HAVERFORD COLLEGE, WEST HAVERFORD, PA.

Observer, H. D. VAIL.

Instrument, an Equatorial of 10 feet focal length; $8\frac{1}{4}$ inches aperture; power used, 60.

Star.	No.	Sidereal Time. — Immersion.			Remarks.
		h	m	s	
<i>Electra</i>	2	4	45	13.55	The atmosphere was very hazy, but remarkably steady, and the moon's bright limb free from undulations. — Too hazy to observe any emersions.
<i>Taygeta</i>	4	4	58	6.60	
<i>Maia</i>	11	5	10	27.74	
<i>Asteropc</i>	13	5	24	42.75	

The times were noted by one of Bond's magnetic registers, and a chronometer was also observed by an assistant. The comparison of the times thus taken showed them to agree well, the greatest difference being about half a second.

1857, December 27.

SOUTHWICK, MASS.

Observer, A. HOLCOMB.

Instrument, a Refractor of 5 feet focal length; 4 inches aperture; power used, 110.

Star.	No.	Mean Time. — Immersion.		
		h	m	s
<i>Electra</i>	2	10	29	50.94

Atmosphere thick, stars quite dim, and a bright halo around the moon.

1857, December 27.

DARTMOUTH COLLEGE, HANOVER, N. H.

Observer, IRA YOUNG.

Instrument, an Equatorial, by Merz and Sons of Munich;
9 feet focal length; aperture, 6.4 inches; power, 85.

Star.	No.	Sidereal Time. — Immersion.		
		h	m	s
<i>Electra</i>	2	4	56	14.05
<i>Maia</i>	11	5	27	23.10

The sky was enveloped in a haze, so dense as to render the brightest stars of the cluster scarcely visible in the telescope.

1857, December 27.

BURLINGTON, N. J.

Observer, SAMUEL J. GUMMERE.

Instrument, an Equatorial, by H. Fitz of New York; 5 feet focal length; 4 inches aperture; power used, 120.

Star.	No.	Burlington Mean Time. — Immersion.
		h m s
<i>Electra</i>	2	10 21 45

After this observation a thick haze obscured all the other stars.

1857, December 27.

WILLIAMS COLLEGE, WILLIAMSTOWN, MASS.

Observer, A. HOPKINS.

Star.	No.	Sidereal Time. — Immersion.
		h m s
<i>Electra</i>	2	4 52 21.0
<i>Taygeta</i>	4	5 13 12.5
<i>Maia</i>	11	5 22 11.0

The smaller stars were obscured by a slight haze.

1857, December 27.

NANTUCKET, MASS.

Observer, WM. MITCHELL.

Instrument, a telescope; 5 feet focal length; $3\frac{3}{4}$ inches aperture.

Star.	No.	Mean Time. — Immersion.
		h m s
<i>Celæno</i>	1	10 40 36
<i>Electra</i>	2	10 47 35
<i>Taygeta</i>	4	11 1 26
<i>Maia</i>	11	11 10 30 ¹
*	14	11 29 21

1857, December 27.

GIBBES'S OBSERVATORY, CHARLESTON, S. C.

Observer, LEWIS R. GIBBES.

Instrument, made by Troughton and Simms, London; 5 feet focal length; diameter of object-glass, $3\frac{3}{8}$ inches; power, 70.

Star.	No.	Mag.	Mean Time.						Remarks.
			Immersion.			Emersion.			
			h	m	s	h	m	s	
<i>Celæno</i>	1	5 $\frac{1}{2}$				10	52	12.8	Uncertain, 1 ^s or 2 ^s .
<i>Taygeta</i>	4	5	9	59	21.0	11	19	33.6	} Imm. good, Em. } uncertain.
<i>Maia</i>	11	5	10	21	20.7	11	27	35.0	
<i>Asterope</i>	13	7 $\frac{1}{2}$	10	25	4.7				Imm. and Em. good.
	14	7 $\frac{1}{2}$	10	28	22.0				Good.
	20	7 $\frac{1}{2}$	10	59	18.3				Good.

Thick haze prevented observations of reappearance of 13, 14, and 20 at bright limb of moon.

¹ Probably 11^h 13^m 30^s. — B. A. G.

1857, December 27.

MR. RUTHERFORD'S NEW OBSERVATORY, N. Y.

Observer, L. M. RUTHERFORD.

Instruments: an 11-inch Equatorial, and Sidereal Chronometer.

Star.	No.	Sidereal Time. — Immersion.	Remarks.
		h m s	
<i>Electra</i>	2	4 51 37.4	Stars seen with the greatest difficulty through a thick haze.
<i>Taygeta</i>	4	5 6 21.5	
<i>Maia</i>	11	5 17 53.8	

The transit instrument was mounted on the same spot as the instrument used by the Coast Survey to determine the longitude of Stuyvesant Garden.

1857, December 27.

KING'S COLLEGE OBSERVATORY, FREDERICTON, N. B.

Observer, W. B. JACK.

Instrument: Equatorial Telescope; focal length, 7 feet 5 inches; aperture contracted to $4\frac{1}{2}$ inches; power used, 80.

Star.	No.	Chronometer Time. — Immersion.	Remarks.
		h m s	
<i>Celæno</i>	1	5 27 2?	{ The exact second somewhat doubtful.
<i>Electra</i>	2	5 27 56	
<i>Taygeta</i>	4	5 55 40?	Doubtful.
<i>Maia</i>	11	6 0 0	Good.
	14	6 26 5	Good.
	33	6 44 48?	Too faint.
	27	6 53 59?	Doubtful, faint.
<i>Alcyone</i>	34	7 1 23	Very good.

OBSERVER'S NOTE. — "From numerous transits observed, the chronometer at 4 sidereal hours was fast 1^m 34^s.5, and at 7 $\frac{1}{2}$ hours it was fast only 1^m 33^s.4. The change I attribute to cold. Temperature being —7° Fahr."

1857, December 27.

CHRISTIANIA OBSERVATORY, NORWAY.

Observers, M. FEARNLEY with a new 9 feet Refractor, and M. THRONDSSEN with the Equatorial.

Star.	No.	Mean Time. — Immersion.	Observers.	Remarks.
		h m s		
24 p <i>Tauri</i>	27	17 29 12.68	Fearnley	Tolerable.
<i>Alcyone</i> η <i>Tauri</i>	31	17 30 3.6	Fearnley	Too late. ¹
		17 30 0.5	Throndsen	Good.
<i>Atlas</i> 27 <i>Tauri</i>	41	17 55 41.5	Fearnley	Very good.

At the beginning of the observations the moon was perfectly covered by clouds; and after these immersions were noted the moon was nearly in contact with the horizon, and enveloped in dense cirro-stratus, and the limb undulated very violently.

¹ The observer had previously left the telescope, and was too late for the precise moment of immersion.

1857, December 27.

MILITARY ACADEMY, WEST POINT, N. Y.

Observer, W. H. C. BARTLETT.

Instrument: Equatorial.

Star.	No.	Sidereal Time. — Immersion.		
		h	m	s
<i>Electra</i>	2	4	50	18.0
<i>Taygeta</i>	4	5	7	20.0
<i>Maia</i>	11	5	18	3.2

The weather during the observations was intensely cold, the sky covered with cirrus clouds, and the moon surrounded by a thick haze.

1857, December 27.

COAST-SURVEY STATION, CANAL AND BASIN
STREETS, NEW ORLEANS.

Observer, E. GOODFELLOW.

Instrument, Zenith Telescope, C. S. No. 5.

Number of Star.		Mag.	Chronometer Time.		Sidereal Time.
B. A. C.	Chart.		Immersion.	Correction.	Immersion.
			h m s	s	h m s
1146	1	5½	3 6 26.5	—52.5	3 5 34.0
1151	4	5	3 22 7.4	—52.5	3 21 14.9
1154	11	5	3 44 38.5	—52.5	3 43 46.0

1857, December 27.

ST. PETERSBURG OBSERVATORY.

Observer, Prof. SAWITSCH.

Star.	No.	St. Petersburg Mean Time. — Immersion.		
		h	m	s
<i>Merope</i>	17	18	12	30

1858, March 19.

SOUTHWICK, MASS.

Observer, A. HOLCOMB.

Instrument, a Refractor of 5 feet focal length; 4 inches aperture; power used, 110.

Star.	No.	Mean Time. — Immersion.		
		h	m	s
<i>Taygeta</i>	4	6	41	33.14
	3	6	46	37.34
<i>Asterope</i>	13	6	58	45.49
	14	7	5	12.59
	20	7	38	8.54
	29	7	44	23.15
* ¹		8	15	22.61

¹ This star (7th mag) is not on the Chart, nor in the Nautical Almanac. The right ascension is about 54° 48' and the declination about 24° 15' N. — The moon's center passed south of it.

1858, March 19.

HAVERFORD COLLEGE, WEST HAVERFORD, PA.

Observer, M. C. STEVENS.

Instrument, an Equatorial of 10 feet focal length; 8¼ inches aperture; power used, 120.

Star.	No.	Chronometer Time.		Sidereal Time.
		Immersion.	Correction.	Immersion.
		h m s	s	h m s
	3	6 19 57.0	—8.0	6 19 49.0
<i>Taygeta</i>	4	6 24 55.0	—8.0	6 24 47.0
<i>Asterope</i>	13	6 39 37.8	—8.0	6 39 29.8
	6	6 42 19.0	—8.0	6 42 11.0
	14	6 47 48.8	—8.0	6 47 40.8

Rate of sidereal clock at time of observation 0^s.37 (gaining).

The following transits were observed and corrected for level.

ε <i>Can Maj.</i>	6	53	12.13
δ <i>Geminorum</i>	7	11	47.46
α ² <i>Geminorum</i>	7	25	39.93
β <i>Geminorum</i>	7	36	46.48

1858, March 19.

WILLIAMS COLLEGE, WILLIAMSTOWN, MASS.

Observer, C. J. LYONS.

Star.	No.	Sidereal Time. — Immersion.		
		h	m	s
<i>Taygeta</i>	4	6	26	19.5
	3	6	34	1.5
<i>Asterope</i>	13	6	44	18.5
	14	6	50	21.5
	20	7	22	59.0
	30	7	28	21.0
	29	7	29	51.0

"I would not be too sure of the correctness of our time, as the transit adjustments were not quite what they ought to be, but do not apprehend any material error." — C. J. L.

1858, March 19.

DARTMOUTH COLLEGE, HANOVER, N. H.

Observer, IRA YOUNG.

Instrument, an Equatorial by Merz and Sons, Munich; 9 feet focal length; aperture, 6.4 inches; power, 85.

Star.	No.	Sidereal Time. — Immersion.		
		h	m	s
<i>Taygeta</i>	4	6	28	27.8
	3	6	40	24.3
<i>Asterope</i>	13	6	47	6.1
	14	6	52	46.1
	20	7	24	6.8
	29	7	32	0.3

The sky was clear during these observations.

Clouds prevented observation of the other stars of the group.

1858, September 26.

NEWARK, N. J.

Observer, ROBERT VAN ARSDALE.

Instrument, Refractor, by Fitz of New York ; $8\frac{1}{2}$ feet focal length ; $6\frac{3}{8}$ inches aperture ; power used, 50.

Star.	No.	Sidereal Time. — Emersion.		
		^h	^m	^s
	3	4	15	24.0

The above time is supposed to be accurate, although it is possible there may be a slight error, as the star emerged somewhat faintly.

1858, September 26.

HAVERFORD COLLEGE, WEST HAVERFORD, PA.

Observer, M. C. STEVENS.

Instrument, an Equatorial of 10 feet focal length ; $8\frac{1}{2}$ inches aperture ; power used, 120.

Star.	No.	Immersion.		
		^h	^m	^s
	3	2	47	24.44

1858, November 20.

DUDLEY OBSERVATORY, ALBANY, N. Y.

Observer, GEORGE SEARLE.

Instrument, the Comet-seeker ; $3\frac{3}{4}$ inches aperture.

Star.	No.	Sidereal Time.					
		Immersion.			Emersion.		
		^h	^m	^s	^h	^m	^s
<i>Electra</i>	2	22	22	22.5	23	15	4.0
<i>Celæno</i>	1				23	22.0	
<i>Taygeta</i>	4				23	30.8	
<i>Maia</i>	11	22	50	41.0	23	48	51.7

The weather was very cloudy at the immersions, which were obtained through breaks in the clouds. At the emersions it was quite clear. *Celæno* was too faint to be observed, and was first seen about a minute after the emersion. *Taygeta* was lost, from attention being directed to another part of the limb.

NOTE. — The Brussels Observations of 1858, August 30, have been misplaced in printing, and will be found on p. 59.

POSITIONS OF PLACES OF OBSERVATION.

	North Latitude.	Longitude from Greenwich.		North Latitude.	Longitude from Greenwich.
	^o ['] ["]	^h ^m ^s		^o ['] ["]	^h ^m ^s
Albany (N. Y.)	42 39 50.0	4 5 58.6 W.	Newark (N. J.)	40 44 20.0	4 56 40.0 W.
Ann Arbor (Mich.)	42 16 48.0	5 31 52.2 W.	New Orleans (La.)	29 57 30.0	6 0 17.0 W.
Brussels (Belgium)	50 51 10.7	0 17 27.6 E.	Newport (Mo.)	38 33 58.0	6 4 37.5 W.
Burlington (N. J.)	40 4 44.0	4 59 23.9 W.	New York (N. Y.)	40 43 48.8	4 55 55.6 W.
Charleston (S. C.)	32 47 5.0	5 19 44.0 W.	Southwick (Mass.)	42 1 50.4	4 51 9.7 W.
Christiania (Norway)	59 54 43.7	0 42 54.8 E.	St. Petersburg (Russia)	59 56 29.7	2 1 13.5 E.
Dorpat (Russia)	58 22 47.6	1 46 50.4 E.	West Haverford (Penn.)	40 0 36.0	5 1 13.0 W.
Fredericton (N. B.)	45 57 15.0	4 26 33.4 W.	West Point (N. Y.)	41 23 31.2	4 55 50.1 W.
Hanover (N. H.)	43 42 30.0	4 49 8.0 W.	Williamstown (Mass.)	42 42 42.0	4 52 51.5 W.
Marburg (Hesse Cassel)	50 48 56.9	0 35 5.6 E.	Wolverhampton (Eng.)	52 37 2.3	0 8 53.6 W.
Nantucket (Mass.)	41 16 57.2	4 40 23.8 W.			

FROM A LETTER OF PROFESSOR ENCKE TO THE EDITOR.

Berlin, 1859, August 13.

THE interesting, but otherwise not especially remarkable, conjunction of *Venus* and *Jupiter*, I have, together with Dr. BRUHNS, observed with great thoroughness. We measured, with the filar micrometer, the distance and angle of position of the two centers. It appeared to us more advantageous to take the center, especially in the case of *Jupiter*, since this planet was, from the beginning, quite faint, and remarkably

so toward the end of the observation, so that the observation of the limbs would have been less trustworthy.

As it is, the differences between observation and computation, according to the method of least squares, are by no means small. Nevertheless, I send you our results, as Dr. BRUHNS has deduced them, having regard to all the corrections.

1859, July 20. Berlin Sidereal Time.	Observed Distance = <i>S</i> .	Observed Angle of Position = <i>P</i> .	Calculated <i>ΔS</i> .	Observed <i>S ΔP</i> .	Observer.	1859, July 20. Berlin Sidereal Time.	Observed Distance = <i>S</i> .	Observed Angle of Position = <i>P</i> .	Calculated <i>ΔS</i> .	Observed <i>S ΔP</i> .	Observer.
^h ^m ^s 23 51 21		253 37.6		—2.55	Bruhns.	^h ^m ^s 0 27 1		208 8.3		—0.69	Encke.
23 57 38	96.94		—0.96		"	0 31 9		191 39.0		—0.01	Bruhns.
23 59 0		248 55.1		+1.41	"	0 32 11	34.66		+0.07		"
0 0 31	87.34		+1.95		"	0 33 3	32.89		+1.47		"
0 4 16		246 27.4		—0.15	Encke.	0 34 3		183 47.3		—2.31	"
0 6 6	77.09		—0.44		"	0 36 18		171 25.5		—0.30	Encke.
0 8 1		243 0.0		+0.24	"	0 37 33	34.61		+1.23		"
0 10 11	68.16		—0.15		"	0 39 11	36.16		+0.95		"
0 12 23		236 59.1		+1.55	Bruhns.	0 41 12		155 10.6		—1.58	"
0 13 26	60.12		+0.74		"	0 42 59		146 56.2		+0.35	Bruhns.
0 15 11	57.80		—0.47		"	0 43 54	42.33		+0.61		"
0 15 49		232 20.6		+1.30	"	0 45 5	48.07		—3.34		"
0 17 1		231 9.1		+0.54	"	0 46 1		140 36.8		—0.74	"
0 17 41	51.08		+1.41		"	0 57 29		121 47.9		+0.78	Encke.
0 19 1		224 51.2		+2.73	"	0 59 57	74.49		—0.29		"
0 19 46	49.36		—0.68		"	1 1 46		119 32.0		—2.34	Bruhns.
0 21 57		221 20.0		+0.09	Encke.	1 2 43	79.77		+0.59		"
0 24 39	39.44		+1.55		"	1 3 34	80.28		+1.70		"
0 25 56	35.89		+3.45		"	1 4 33		116 27.0		—1.03	"

The Ephemeris of both these planets in the *Jahrbuch* will have to be improved.

$$d(\alpha' - \alpha) = +10''.85; d(\delta' - \delta) = +0''.75.$$

The minimum of distance occurred at 0^h 33^m.5, and amounted to 34''.4. According to Professor WOLFERS, it should have taken place at 0^h 29^m.5, and amounted to 33''.3.

ENCKE.

NEW WORKS.

1. *Astronomische Beobachtungen auf der Königlichen Universitäts-Sternwarte zu Königsberg. Zwei und dreissigste Abtheilung*, 1859. — This volume contains the observations by Professor BUSCH, with the Reichenbach and Repsold meridian-circles, during the years 1847 to 1855; and its publication by Professor LUTHER completes the record of all the observations of the Königsberg Observatory, down to the close of the year 1857, — the thirty-third volume having been published about a year since. During the printing the observatory suffered an afflictive bereavement, by the death, 1859, February 7, of the gifted Dr. WICHMANN, an observer since 1844, and recently associated in its direction with Professor LUTHER, who, in the Preface to the present volume, offers a graceful tribute to his memory.

2. *Report on the Tenerife Astronomical Experiment of 1856, addressed to the Lords Commissioners of the Admiralty, by Professor C. PIAZZI SMYTH, H. M. Astronomer for Scotland*. — This elegant volume of 140 pages, published by the

Admiralty, contains, in addition to the portion of the report printed in the *Philosophical Transactions*, chapters of much interest upon the Geology and Botany of the Peak, and miscellaneous observations, — published through the agency of the Astronomer Royal. The physical investigations, especially those relating to the atmosphere of the Peak, and its influence upon astronomical observations, are of much interest; and the work is adorned with elegant photographs.

3. *Die merkwürdigen arithmetischen Eigenschaften der wichtigsten Näherungsreihe für die Sonnenabstände der Planeten, &c. Von Prof. Dr. J. F. C. HESSEL*. Marburg, 1859. — A historical investigation of the formula of TITIVS, with a discussion of its arithmetical properties, and the deductions to be attained upon the assumption of a law of nature regulating or limiting the successive planetary distances. It is published in a form of a commemoration of the fiftieth academic anniversary of Professor CARL REINHARD MÜLLER, 1859, April 17.

G.

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NEW WORKS.

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NO. 9.

ON THE SECULAR VARIATIONS OF THE ECCENTRICITIES AND PERIHELIONS OF THE ASTEROIDS VESTA, METIS, HYGEA, AND PARTHENOPE.

By SIMON NEWCOMB.

THE question whether the orbits of all the asteroids could ever have passed through the same point at the same time has not been satisfactorily settled. At present, the most promising way of treating it seems to be to obtain expressions as nearly rigorous as possible for the values of the elements during all time, and then to determine whether these expressions are such as to admit of a common point of intersection of the orbits. Let us treat by this method the asteroids *Vesta*, *Metis*, *Hygea*, and *Parthenope*. I select these four, as most nearly complying with the following conditions:—

1. That the eccentricities and inclinations should not be so great that the neglect of quantities of the third order with respect to them would render the equations seriously defective.

2. That the present values of the elements should be tolerably well determined.

3. That a large range of mean distances should be included.

Let us put,

k = the Gaussian constant, or mean motion of the earth in a unit of time;

a, a' , the mean distances of an asteroid and an *outer* disturbing planet, or of an *inner* disturbing planet and the asteroid;

m , the mass of the disturbing planet;

$h = a k n \sqrt{1 - e^2} = \frac{k \sqrt{1 - e^2}}{\sqrt{a}}$ (the elements being those of the disturbed planet);

$\frac{1}{2} b_s^{(i)}$, the coefficient of $\cos i\varphi$ in the development of

$$\left(1 - 2 \frac{a}{a'} \cos \varphi + \frac{a^2}{a'^2}\right)^{-s},$$

the quantities which LAPLACE (*Mécanique Céleste*, Liv. II. No. 55) represents by $(0/1), (0/2) \dots [0/1], [0/2], \&c.$, may be put into the simple form,

$$\left. \begin{aligned} (0/n) &= \frac{m}{4} \frac{h}{a'^2} \frac{a}{b_s^{(1)}}; \\ [0/n] &= \frac{m}{4} \frac{h}{a'^2} \frac{a}{b_s^{(2)}}. \end{aligned} \right\} \quad (1)$$

If we then put

$$b = e \sin \pi, \quad c = e \cos \pi;$$

the equations (A) of the same number become

$$\left. \begin{aligned} D_t b &= c \sum_n (0/n) - \sum_n [0/n] c_n; \\ D_t c &= -b \sum_n (0/n) + \sum_n [0/n] c_n. \end{aligned} \right\} \quad (2)$$

The different values of n here refer to the different disturbing planets.

The simultaneous integration of these equations, b, b_n, c, c_n , being all supposed unknown, except for a given epoch, involves a tedious course of computation. In our present investigation, however, we neglect the action of the asteroids on each other, and also on the larger planets; we may, therefore, use for b_n and c_n the values of those quantities already found by astronomers. Expressed in terms of the time, these values are of the form,

$$\left. \begin{aligned} b_n &= \binom{0}{n} \sin(gt + \beta) + \binom{1}{n} \sin(g_1 t + \beta_1) + \binom{2}{n} \sin(g_2 t + \beta_2) + \&c. \\ c_n &= \binom{0}{n} \cos(gt + \beta) + \binom{1}{n} \cos(g_1 t + \beta_1) + \binom{2}{n} \cos(g_2 t + \beta_2) + \&c. \end{aligned} \right\} \quad (3)$$

$\binom{0}{n}, g$, and β denoting known constant quantities. Substituting these expressions in equation (2), and putting, for brevity,

$$\begin{aligned} p_n &= [0/1] \binom{1}{n} + [0/2] \binom{2}{n} + [0/3] \binom{3}{n} + \&c.; \\ A &= \sum_n (0/n); \end{aligned}$$

we have

$$D_t b = A c - \sum p_n \cos (g_n t + \beta_n);$$

$$D_t c = -A b + \sum p_n \sin (g_n t + \beta_n). \quad (4)$$

These equations, when integrated by known methods, give

$$b = H \sin (A t + L) + \sum \frac{p_n}{g_n - A} \{ \sin (A t + \beta_n) - \sin (g_n t + \beta_n) \}$$

$$c = H \cos (A t + L) + \sum \frac{p_n}{g_n - A} \{ \cos (A t + \beta_n) - \cos (g_n t + \beta_n) \}$$

H and L being arbitrary constants. If instead of these constants we use others, α and l , determined by the conditions,

$$\alpha \sin l = H \sin L + \sum \frac{p_n}{g_n - A} \sin \beta_n$$

$$\alpha \cos l = H \cos L + \sum \frac{p_n}{g_n - A} \cos \beta_n$$

the integrals may be put into the form,

$$(5) \begin{cases} b = \alpha \sin (A t + l) + \sum \frac{p_n}{A - g_n} \sin (g_n t + \beta_n) \\ c = \alpha \cos (A t + l) + \sum \frac{p_n}{A - g_n} \cos (g_n t + \beta_n) \end{cases}$$

α and l are fixed by the values b and c , at a given epoch. It follows from these expressions, that if A were very nearly equal to any value of g_n , the eccentricity of the asteroid might,

though very small at the origin of time, attain a great magnitude. But since this condition is not fulfilled for any of the asteroids, we cannot attribute to its mathematical possibility the large eccentricity of most of them.

In reducing the above expressions for b and c to numbers, I have used the values of the constants given by LEVERRIER in the second volume of his *Annales de l'Observatoire*, applying to the arguments g_n the corrections given in the appendix to the same volume for terms of the third order. The values of the masses of the disturbing planets, and of the elements of the asteroids, have been taken from the *American Ephemeris*, and from the supplement to the volume of that work for 1861. The direct action of *Mercury* has been neglected.

The following are the numerical results :—

Values of log (0/n).					Values of log [0/n].				
	Vesta.	Metis.	Hygea.	Parthenope.		Vesta.	Metis.	Hygea.	Parthenope.
Venus	3.5734	3.5544	3.0989	3.5092	Venus	3.1512	3.1277	2.5540	3.0709
Earth	3.9768	3.9560	3.4638	3.9058	Earth	3.6901	3.6651	3.0569	3.6035
Mars	3.7462	3.7170	3.0832	3.6159	Mars	3.6258	3.5928	2.8509	3.5114
Jupiter	6.25088	6.26044	6.62428	6.29219	Jupiter	5.99257	6.00635	6.47999	6.04931
Saturn	4.8000	4.8063	5.0298	4.8286	Saturn	4.2872	4.2978	4.6391	4.3320
Uranus	2.9987	3.0041	3.1958	3.0240	Uranus	2.1851	2.1949	2.5066	2.2267
Neptune	2.5294	2.5348	2.7207	2.5546	Neptune	1.5215	1.5313	1.8376	1.5631

Each of the above logarithms has been increased by 10 to make it positive. The unit of time to which they correspond is a Julian year. From the first set we obtain,

for	Vesta,	$A = .00018651 = 38.471$
	Metis,	$A = .00019046 = 39.285$
	Hygea,	$A = .00043246 = 89.204$
	Parthenope,	$A = .00020441 = 42.763$

Using for the coefficients, which I have denoted by $\binom{0}{1}$, $\binom{0}{2}$, ..., $\binom{1}{1}$, $\binom{1}{2}$, ..., &c., the values given by LEVERRIER (*Annales de l'Observatoire*, Tom. II., pp. 117, 169), we obtain the following values of p_n , expressed in units of the ninth place of decimals.

	Vesta.	Metis.	Hygea.	Parthenope.
p	+ 307	317	936	349
p_1	+ 4277	4413	13035	4866

	Vesta.	Metis.	Hygea.	Parthenope.
p_2	— 1423	1471	4472	1628
p_3	+ 8	8	2	7
p_4	— 14	13	3	11
p_5	+ 16	15	3	13
p_6	+ 25	23	4	19
p_7	+ 10	10	29	11

The values of g_n , when corrected for terms of the third order, become as follows :

$g = 2.90$	$g_1 = 3.80$	$g_2 = 22.82$	$g_3 = 5.30$
$g_4 = 7.57$	$g_5 = 17.15$	$g_6 = 17.86$	$g_7 = 0.69$

Let us put, for brevity,

$$\begin{aligned} (1) &= g t + 97^\circ 50'; & (2) &= g_1 t + 25^\circ 52' \\ (3) &= g_2 t + 126^\circ 37'; & (4) &= g_3 t + 35^\circ 0' \end{aligned}$$

And we have, retaining only four places of decimals,

For *Vesta*.

$$\left. \begin{aligned} b &= .0018 \sin (1) + .0251 \sin (2) - .0188 \sin (3) + .0002 \sin (4) + .1051 \sin (38^\circ 47' t + 230^\circ 56') \\ c &= .0018 \cos (1) + .0251 \cos (2) - .0188 \cos (3) + .0002 \cos (4) + .1051 \cos (38^\circ 47' t + 230^\circ 56') \end{aligned} \right\}$$

For *Metis*.

$$b = .0018 \sin (1) + .0256 \sin (2) - .0184 \sin (3) + .0002 \sin (4) + .1182 \sin (39''.28 t + 85^\circ 40')$$

$$c = .0018 \cos (1) + .0256 \cos (2) - .0184 \cos (3) + .0002 \cos (4) + .1182 \cos (39''.28 t + 85^\circ 40')$$

For *Hygea*.

$$b = .0022 \sin (1) + .0315 \sin (2) - .0139 \sin (3) + .1310 \sin (89''.20 t + 215^\circ 36')$$

$$c = .0022 \cos (1) + .0315 \cos (2) - .0139 \cos (3) + .1310 \cos (89''.20 t + 215^\circ 36')$$

For *Parthenope*.

$$b = .0018 \sin (1) + .0262 \sin (2) - .0174 \sin (3) + .0002 \sin (4) + .0779 \sin (42''.16 t + 297^\circ 12')$$

$$c = .0018 \cos (1) + .0262 \cos (2) - .0174 \cos (3) + .0002 \cos (4) + .0779 \cos (42''.16 t + 297^\circ 12')$$

(6)

Let us next determine whether the orbits of *Vesta* and *Hygea* could ever have intersected, while the values of b and c nearly coincide with those obtained from the above expressions. We first remark that the eccentricity of *Vesta* may approach indefinitely near the limit .1513, and that of *Hygea* may approach the limit .1786. If the eccentricities could attain these limits, the aphelion distance of *Vesta* would be 2.719, and the perihelion distance of *Hygea*, 2.587; so that the perihelion distance of *Hygea* was not always greater than the aphelion distance of *Vesta*. But a little examination of the above expressions for b and c will show that, in consequence of the coefficients of the common angles (1), (2), (3), (4) having the same sign for *both* planets, whenever the eccentricities of both planets are, at the same time, near their greatest value, the perihelions will be in the same quarter of the heavens, and *vice versa*, if the perihelion of one planet is near

the aphelion of the other, the sum of the eccentricities cannot much exceed its mean value.

To consider the problem more rigorously, put p and p' for the semi-parameters of the orbits, and v for the longitude of the point of intersection. We must then have

$$\frac{p'}{1 + e' \cos (v - \pi')} = \frac{p}{1 + e \cos (v - \pi)}$$

or,

$$p - p' + (p b' - p' b) \sin v + (p c' - p' c) \cos v = 0.$$

In order that this equation may be possible, we must have

$$(p b' - p' b)^2 + (p c' - p' c)^2 > (p' - p)^2.$$

Since b and c are of the form,

$$b = \Sigma y \sin (n) + a \sin l, \quad b' = \Sigma y' \sin (n) + a' \sin l'$$

$$c = \Sigma y \cos (n) + a \cos l, \quad c' = \Sigma y' \cos (n) + a' \cos l'$$

the above inequality is equivalent to

$$\{\Sigma (p y' - p' y) \cos (n) + p a' \cos l' - p' a \cos l\}^2 + \{\Sigma (p y' - p' y) \sin (n) + p a' \sin l' - p' a \sin l\}^2 > (p' - p)^2. \quad (7)$$

The variations of the parameters being very small, if we use the mean values of the latter, the quantity

$$\{\Sigma (p y' - p' y) \pm p a' \pm p' a\}^2$$

will be very nearly the greatest possible value of the first member of (7), the doubtful signs being so taken that the absolute value of the quantity within the parenthesis shall be as great as possible. Reducing to numbers, we have

$$\Sigma (p y' - p' y) + p a' + p' a = 0.66 \text{ nearly;}$$

and

$$p' - p = 0.79 \text{ nearly.}$$

It follows, therefore, that the orbits of *Vesta* and *Hygea* could never have intersected while the equations (6) are approximately true. Since the maximum value which the first member of (7) can attain is independent of the angles a , (1), (2), &c., and since any reasonable change in the assumed masses of the planets would sensibly affect only those angles, this result is not affected by the errors in the masses.

COMPARISON OF THE LUNAR EPHEMERIS IN THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC WITH GREENWICH OBSERVATIONS.

By SIMON NEWCOMB.

[Communicated by Captain C. H. DAVIS, Superintendent.]

Nautical Almanac Office, 1859, October 13.

DEAR SIR:—The following table exhibits the results of a comparison of the Lunar Ephemeris in the *American Nautical Almanac* for 1856 and 1857 with the observations made with the Greenwich meridian-circle in those years. The comparisons were not made directly, but in the following manner. The right-ascension or declination of the moon, given in the *British Nautical Almanac* for the hour nearest the instant of observation, was subtracted from the value of the corresponding coördinate given in the *American Ephemeris*, and the difference added to the corresponding number in the column of the Greenwich Observations headed “Apparent Error of Tables in (α or NPD),” to obtain the apparent error of the Ephemeris. The differences are therefore “computed *minus* observed.”

1857.												
		Δa	ΔNPD			Δa	ΔNPD			Δa	ΔNPD	
July	7	^s +0.22	["] -5.1	Sept.	11	^s -0.50	["] +1.7	Nov.	22	^s -0.14	["] -3.4	
	9	+0.18	-2.5		24	+0.29	24		-0.18	+0.9		
	11	-0.28	+1.8		28	+0.11	-5.8		27	+0.20	-1.3	
	12	-0.48	+4.5		29	+0.23	-5.3		28	+0.18	-2.4	
	14		+1.2		30	+0.05	-5.8		29	+0.01	-2.6	
Aug.	31	+0.16	-1.8	Oct.	1	-0.09	-4.5	Dec.	30	-0.19	-0.1	
	2	+0.13	-2.2		2	-0.29	+1.3		1	-0.39	+0.9	
	3	-0.21	-3.8		6	-0.28	-1.1		2	-0.43	+0.6	
	4	-0.01	-6.4		8	-0.35	+0.9		3	-0.22	+1.3	
	9	-0.63	+5.8		9	-0.47	+1.1		4	-0.02	+1.5	
Sept.	25	-0.16	0.0	Nov.	23	+0.10			7	+0.01	+1.6	
	26	+0.02			25	-0.05	-4.9		10	-0.03	+2.3	
	29	+0.09	-3.6		26	-0.13	-4.3		25	-0.23	+3.9	
	30	+0.19	-4.2		27	-0.05	-3.8		27	+0.11	+0.9	
	31	+0.31	-5.5		29	-0.06	-7.6		28	+0.25	+0.3	
	1	+0.10	-4.6		30	-0.03	-4.1		29	(+0.51)	-3.5	
	4	+0.22	-1.4		31	-0.19	-3.4		30	-0.05	+1.1	
	5	-0.17	+2.1		Nov.	1	-0.33		0.0	31	-0.47	-0.2
	6	-0.34	+3.4			5	+0.24		+2.2			

The following are some deductions from the above table.

The mean error in a for 1856 is 0'.235; for 1857, 0'.184; for both years, 0'.205.

	1856.	1857.	Total.	Probable Number.
From ^s 0.00 to ^s 0.09	25	36	61	63
0.10 0.19	19	37	56	57
0.20 0.29	25	26	51	43
0.30 0.39	13	10	23	27
0.40 0.49	10	6	16	15
0.50 0.59	2	1	3	7
0.60 0.69	2	3	5	3
0.70 0.79	1	0	1	1
0.80 0.89	1	0	1	0

The distribution of the errors is exhibited in the second,

third, and fourth columns of the preceding table. The last column contains the most probable number of errors *a priori*, supposing the law of their facility to be that usually assumed.

The *a priori* probability that an error exceeding 0'.80 would be found in 217 observations, when the mean error is 0'.205, is only about $\frac{1}{5}$.

The sum of the squares of the errors is probably within the limits $14'.3 (1 \pm \frac{1}{50}) = 3217'' (1 \pm \frac{1}{50}) \times 0.889$.

The probable error, from the two years' observation, is 0'.173; or, when reduced to a great circle, by multiplying by $15 \int i \cos \delta du = 15 \int \sqrt{r - \sin^2 i \sin^2 u} du = 15 \times .943$, (i being the inclination of the moon's orbit to the equator, and u its longitude,) the probable error in a becomes 2''.45.

The mean error in δ is 2''.03; the probable error, therefore, is about 1''.71.

SIMON NEWCOMB.

OBSERVATIONS OF MASSALIA, EUPHROSYNE, AND PROSERPINE.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

MASSALIA.

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta \delta$ ⁽²⁰⁾ - *	Δa	α ⁽²⁰⁾ s apparent	δ
1859, July 29	^h 10 ^m 36 ^s 49.7	5	B. A. C. 7263	^m -1 ^s 14.61	-9' 2".22	^h 20 ^m 48 ^s 36.18	-16° 43' 4".61
Aug. 10	9 25 9.9	10	A. C. 20838	-1 34.00	-5 42.84	20 36 57.19	17 28 48.34
10	9 25 9.9	10	" 20840	-1 41.52	-16 42.31	20 36 57.12	17 28 50.29

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
B. A. C. 7263	6	^h 20 ^m 49 ^s 49.91	-16° 34' 4".52	British Association Catalogue. Argelander's Catalogue.
A. C. 20838	9	20 38 30.26	17 23 18.58	
" 20840	8.5	20 38 37.70	17 12 20.91	

EUPHROSYNÉ.⁽¹⁾

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽³¹⁾ — *	$\Delta\delta$	α ⁽³¹⁾ 's apparent	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	[°] ['] ["]
1859, Sept.	1 11 27 31.8	2	2	—0 3.65	—16 4.52	23 8 18.41	—10 17 52.61
	6 11 45 43.2	3	4	+0 31.98	—17 41.39	23 2 59.47	40 22 7.29
	26 9 52 13.0	7	B. A. C. 7957	+0 9.21	+11 22.60	22 43 14.83	39 39 29.98
	28 9 51 37.1	6	5	—2 40.81	+11 59.42	22 41 32.64	39 29 40.38
Oct.	4 9 18 9.0	6	B. A. C. 7944	—2 52.05	+2 28.71	22 36 58.73	—38 55 54.79

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
2	8	23 8 20.06	—10 1 53.96	} Washington Equatorial from B. A. C. 8045. British Association Catalogue. Washington Equatorial from B. A. C. 7957. British Association Catalogue.
4	8	23 2 25.72	40 5 6.42	
B. A. C. 7957	6	22 43 3.85	39 53 49.92	
5	8	22 44 11.71	39 41 38.10	
B. A. C. 7944	7	22 39 49.11	—38 57 21.31	

PROSERPINE.

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽²⁶⁾ — *	$\Delta\delta$	α ⁽²⁶⁾ 's apparent	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	[°] ['] ["]
1859, Oct.	19 9 40 14.2	11	B. Z. 337, 20	+0 26.68	+2 21.79	3 54 27.95	+16 0 22.24
	20 9 8 49.2	18	" 337, 20	—0 22.21	—0 9.45	2 53 39.07	15 57 51.06
	21 9 45 10.9	11	" 337, 20	—1 14.09	—2 49.98	2 52 47.21	15 55 10.72
	31 9 26 3.4	6	{ Rümker, 1446	+0 55.99	+17 7.50	2 43 49.86	15 26 10.59
Nov. 1	8 58 59.4	15	{ Neue Folge	+0 1.06	+14 0.74	2 42 54.95	+15 23 3.85

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
B. Z. 337, 20	8	2 54 0.06	+15 57 49.82	Bessel's Zones.
Rümker, N. F., 1446 ⁽²⁾	9	2 49 49.10	+15 8 36.71	Rümker, Neue Folge.

⁽¹⁾ The Observations of *Euphrosyne* taken with great difficulty. Those of September 26 and October 4 should be most reliable.

⁽²⁾ This star is probably Bessel's Zones, 337, 8. If so, 20 seconds is to be added to Bessel's α .

OF THE MEAN PLACES FOR 1855.0 OF FORTY-EIGHT CIRCUMPOLAR STARS.

By B. A. GOULD, Jr.

(Continued from No. 122.)

SYNOPTICAL TABLE OF DECLINATIONS FOR 1855.

	1. 21 <i>Cassiopeæ</i> .	2. <i>Polaris</i> .	3. A <i>Cassiopeæ</i> .	4. 50 <i>Cassiopeæ</i> .	5. ι <i>Cassiopeæ</i> .	6. 48 <i>Cephei</i> .
Bradley	74° 11' 38.5	88° 32' 11.3	69° 30' 58.4	71° 42' 57.8	66° 44' 47.9	77° 11' 40.0
Lalande	39.6	11.0	58.6	0.0	48.9	[41.9]
Piazzi	38.3	11.2	[63.2]	58.8	[46.9]	40.0
Groombridge	38.3	11.7	57.9	[56.9]	48.3	[41.8]
Struve	39.3	11.2			47.6	
Argelander				58.9		
Pond		11.0	57.7	57.4	48.2	39.9
Airy		11.2	58.7	59.0	48.1	
Johnson	38.4	11.5	58.5	58.3	48.4	40.1
	74 11 39.0	88 32 11.2	69 30 58.3	71 42 58.6	66 44 48.0	77 11 40.0
	±0.47	±0.10	±0.31	±0.38	±0.18	±0.10

SYNOPTICAL TABLE OF DECLINATIONS FOR 1855 — (*continued*).

	7. <i>α Camelopardalis.</i>	8. Groombridge 966.	9. <i>22 Camelopardalis.</i>	10. <i>51 Cephei.</i>	11. Piazzi VII. 67.	12. <i>3 Ursæ Majoris.</i>
Bradley						
Lalande		74° 56' 14".7		87° 15' 5".1	68° 45' [20.3]	68° 53' 39".4
Piazzi	66° 5' 21".0		69° 21' 44".9	13.1	15.8	
Groombridge	20.3	15.5	44.6	11.2	14.0	38.9
Struve	21.0					
Argelander						
Pond	21.6	14.7	41.7	6.6	15.0	39.8
Airy	20.5	14.9	41.5	8.6	15.4	39.2
Johnson	20.9	15.0	45.0	9.8	14.8	39.1
	66 5 21.0 ±0.23	74 56 14.9 ±0.09	69 21 44.7 ±0.15	87 15 8.3 ±0.94	68 45 15.1 ±0.18	68 53 39.4 ±0.22
	13. <i>α² Ursæ Majoris.</i>	14. <i>1 Draconis.</i>	15. <i>24 Ursæ Majoris.</i>	16. <i>32 Ursæ Majoris.</i>	17. <i>9 Draconis.</i>	18. <i>λ Draconis.</i>
Bradley	67° 43' 6".4		70° 27' 48".6	65° 49' 44".9	76° 27' [23.9]	70° 7' 50".3
Lalande	3.6	81° 57' 37".8	[41.3]	45.2	26.4	51.5
Piazzi	3.3	39.3	48.9	45.6	27.1	48.7
Groombridge	6.8	38.9	49.2	45.7	[28.3]	51.2
Struve	4.7					50.1
Argelander	4.9					
Pond		37.9	48.6		26.8	49.4
Airy	5.5	38.1	48.2	45.1	26.6	50.5
Johnson	5.8	38.9	49.0	45.0	26.7	50.8
	67 43 5.0 ±0.29	81 57 38.3 ±0.31	70 27 48.6 ±0.23	65 49 45.0 ±0.07	76 27 26.7 ±0.06	70 7 50.2 ±0.30
	19. <i>4 Draconis.</i>	20. <i>α Draconis.</i>	21. <i>32 Camelop. (foll.)</i>	22. <i>α Draconis.</i>	23. <i>5 Ursæ Minoris.</i>	24. <i>β Ursæ Majoris.</i>
Bradley	78° 25' [15.7]	70° 35' 16".1	84° 11' [59.5]	65° 4' [7.7]	76° 20' 25".3	74° 44' 52".9
Lalande	18.5	15.6	64.1	11.3	25.7	51.3
Piazzi	19.5	15.9	63.7	10.3	24.8	[50.1]
Groombridge	19.2	16.1	63.5	11.8	25.5	51.8
Struve		16.3	63.3	10.9	25.4	52.1
Argelander				11.0	25.2	52.2
Pond	18.5	16.0	63.7	10.1	24.7	52.5
Airy	19.1	15.8	64.2	11.4	25.4	52.6
Johnson	18.9	16.0	63.9	11.3	25.7	52.4
	78 25 18.8 ±0.18	70 35 16.1 ±0.11	84 12 3.7 ±0.19	65 4 11.0 ±0.23	76 20 25.3 ±0.17	74 44 52.3 ±0.10
	25. <i>γ² Ursæ Minoris.</i>	26. <i>ζ Ursæ Minoris.</i>	27. Groombridge 2320.	28. <i>15 Draconis.</i>	29. <i>ε Ursæ Minoris.</i>	30. <i>ω Draconis.</i>
Bradley	72° 20' [57.2]	78° 14' 17".4		69° 4' 53".9	82° 16' 6".7	68° 49' 27".0
Lalande	59.2	19.3	68° 11' 32".8	[58.1]	5.9	27.7
Piazzi	60.8	17.2		55.9	8.7	[30.0]
Groombridge	59.9	18.3	32.4	54.6	6.8	25.8
Struve	60.4	18.0			6.7	
Argelander	60.3	18.2				26.9
Pond	59.5	17.8	32.3	54.4	6.6	27.2
Airy	59.7	17.7	32.5	54.2	6.5	28.3
Johnson	59.9	17.8	32.8	54.3	7.1	25.9
	72 21 0.1 ±0.19	78 14 18.0 ±0.10	68 11 32.5 ±0.15	69 4 54.3 ±0.06	82 16 6.7 ±0.13	68 49 27.0 ±0.50

SYNOPTICAL TABLE OF DECLINATIONS FOR 1855 — (continued).

	31. <i>ψ</i> Draconis (pr.)	32. <i>δ</i> Ursæ Minoris.	33. 50 Draconis.	34. <i>δ</i> Draconis.	35. <i>τ</i> Draconis.	36. <i>ε</i> Draconis.
Bradley	72° 13' 7.2"	86° 35' 58.1"	75° 15' 37.0"	67° 24' 22.8"	73° 5' 5.1"	69° 53' 54.4"
Lalande	6.1	[59.4]	[41.7]	24.0	5.3	[50.1]
Piazzi	9.0	57.8	39.2	23.2	5.8	52.6
Groombridge	7.9	57.4	36.9	22.5	[3.9]	53.2
Struve	7.5	58.0		22.9		53.7
Argelander	7.6			23.4		
Pond	7.0	57.2	[30.5]	23.1	5.4	54.5
Airy	7.2	58.7		23.3	5.0	54.2
Johnson	7.4	58.2	37.3	23.1	5.4	53.7
	72 13 7.4 ±0.11	86 35 58.0 ±0.31	75 15 37.3 ±0.0	67 24 23.2 ±0.09	73 5 5.3 ±0.14	69 53 54.0 ±0.20
	37. <i>λ</i> Ursæ Minoris.	38. <i>α</i> Cephei.	39. Groombridge 3241.	40. T.Y.C. 1879.	41. <i>β</i> Cephei.	42. 11 Cephei.
Bradley	88° 52' 32.1"	77° 16' 20.9"	72° 2' 24.7"		69° 55' 28.7"	70° 38' 39.2"
Lalande	32.3	21.6	25.3	80° 0' 21.1"	[31.3]	38.1
Piazzi	[30.2]	19.4	22.7		[25.9]	37.1
Groombridge	32.2	20.0	23.2	20.1	28.6	38.4
Struve		20.5			28.3	
Argelander	32.2			20.9	28.4	
Pond	31.9	20.8	25.0	20.8	28.6	39.5
Airy	32.1	20.8		21.0	28.7	39.5
Johnson	32.4	21.0	24.7	20.7	28.7	38.3
	88 52 32.2 ±0.11	77 16 20.7 ±0.11	72 2 24.8 ±0.16	80 0 20.9 ±0.07	69 55 28.5 ±0.08	70 38 39.1 ±0.40
	43. 79 Draconis.	44. 226 Cephei.	45. <i>ι</i> Cephei.	46. <i>ο</i> Cephei.	47. <i>γ</i> Cephei.	48. Groombridge 4163.
Bradley	73° 0' 59.9"		65° 26' 18.1"	67° 19' [2.8]	76° 49' 23.1"	
Lalande	60.6	75° 28' 45.2"	19.4	6.7	24.1	73° 36' 12.9"
Piazzi	59.8		18.1	6.4	22.7	
Groombridge	61.0	45.3	19.2	[5.1]	23.6	[10.9]
Struve			18.4	6.0	23.8	
Argelander			18.4		24.0	
Pond		46.4	18.7		24.1	12.7
Airy	60.3		18.3	6.4	23.5	
Johnson	59.7	44.7	18.5	6.7	22.4	11.9
	73 1 0.0 ±0.30	75 28 45.6 ±0.85	65 26 18.4 ±0.07	67 19 6.3 ±0.21	76 49 23.7 ±0.32	73 36 12.3 ±0.40

(To be continued.)

FIFTY-SEVENTH ASTEROID.

The small planet discovered by Dr. LUTHER, at Bilk, September 22, has received the name of *Mnemosyne*.

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- COMPARISON OF THE LUNAR EPHEMERIS IN THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC WITH GREENWICH OBSERVATIONS, BY MR. SIMON NEWCOMB.
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- ON THE MEAN PLACES FOR 1855.0 OF FORTY-EIGHT CIRCUMPOLAR STARS, BY B. A. GOULD, JR.
- FIFTY-SEVENTH ASTEROID.

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NO. 10.

ON THE MEAN PLACES FOR 1855.0 OF FORTY-EIGHT CIRCUMPOLAR STARS.

REPORT TO PROFESSOR A. D. BACHE, SUPERINTENDENT OF THE U. S. COAST SURVEY.

By B. A. GOULD, Jr.

[Communicated by Authority of the Hon. Secretary of the Treasury.]

(Continued from No. 129.)

By comparison of the final positions, thus obtained, with the places as deduced from the several authorities, we may arrive at a thorough judgement of the accuracy of the reductions to the adopted equinoctial point, as well as of the trustworthiness of our results. A table, which presents the results of such comparisons in detail, is given on the next page. It shows, for each authority, the difference between the catalogue-place of each star and the corresponding place as indicated by the present discussion; the numbers given being the residuals left, by subtracting from the catalogue-places, in each instance, the positions given in the synoptical tables, — after reference to the mean equinox of the catalogue, employment of the proper-motions of page 13, and application of the personal equations of pages 9 and 14. The mean difference and the average discordance are also given for each authority, excluding, however, the right-ascensions of the four polar stars. The indications of this table must, I think, be regarded as extremely satisfactory, whether as regards the very small mean differences between our resultant values and those of the several authorities, notwithstanding the large range of 34° in the polar distance, or as regards the narrow limits of the discordances. The residuals corresponding to the rejected observations (already enumerated) are inclosed in brackets; and an examination of this table will, I think, tend to justify the rejection in cases which might otherwise appear doubtful. It will be remarked that none of the observations at Dorpat, Åbo, Pulkowa, Greenwich, or Oxford have required rejection.

The right-ascensions of the four polar stars of our catalogue

have received a special and more minute discussion than that described, in consequence both of the greater discordance of the authorities (as measured in time) and of the necessity of taking account of the terms of a higher order in the precession. The results of this discussion I will condense, as far as may be, into a tabular form. The first of the tables (page 75) shows the several recorded right-ascensions, and the same as referred to the mean equinox of 1850.0 and the zero of ARGELANDER. The second gives the right-ascensions and proper-motions obtained from these by application of the method of least squares, together with their mean errors and the corresponding right-ascensions for 1855.0. To the mean of each year's observations at Greenwich and Oxford — from which the greater part of our data has been derived — was assigned the weight $\frac{11n}{10+n}$, where n denotes the number of observations during the year; while to each other authority was assigned the maximum weight given to the observations of any one year at these observatories. And, finally, the table on page 76 presents a synopsis of the several observations and their residual errors, deduced as before, and by the use of the same weights as before assigned (page 14).

The right-ascensions thus deduced appear entitled to great reliance. The greatest deviation from the places of the *British Nautical Almanac* and the *American Ephemeris* is the star λ *Ursæ Minoris*, the right-ascension of which seems to be given about one second too large. On the other hand, the right-ascensions deduced for 51 *Cephei* is about one second larger than that of the *Nautical Almanac*.

COMPARISON WITH THE SEVERAL AUTHORITIES.
RESIDUAL ERRORS.

No.	NAME.	BRADLEY.		LALANDE.		PIAZZI.		GROOMBRIDGE.		STRUVE.		ARGELANDER.		POND.		PETERS.		AIRY.		JOHNSON.	
		$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha$	$\Delta\delta$
1	21 Cassiopeæ	$[-1.57]$	-0.5	+0.11	+0.6	+0.31	-0.7	-0.47	-0.7	-0.15	+0.3			-0.78	-0.2			-0.21	0.0	-0.30	-0.6
2	10 Icaris	-0.58	+0.1	-0.85	-0.2	+2.62	0.0	+1.70	+0.5	-0.23	0.0			-0.03	-0.6			+0.02	+0.1	-0.47	+0.3
3	4 Cassiopeæ	-0.06	+0.1	+0.65	+0.3	-0.43	[+4.9]	-0.06	[+1.7]					+0.01	-1.2			+0.25	+0.1	-0.16	-0.3
4	50 Cassiopeæ	+0.27	-0.8	-0.28	+1.4	-0.13	+0.2	0.00	-0.3	+0.02	-0.4	-0.05	+0.3	-0.11	+0.2			+0.01	+0.1	+0.08	+0.4
5	1 Cassiopeæ	+0.02	-0.1	-0.05	+0.9	+0.52	[-1.1]	0.00	+0.3					-0.15	-0.1					-0.15	+0.1
6	48 Cephei	0.0	0.0	-0.07	[+1.9]	-0.39	0.0	-0.82	[+1.8]	+0.01	0.0			-0.09	+0.6			-0.23	-0.5	-0.23	-0.1
7	α Camelopardalis			+0.03	-0.2	-0.01	0.0	+0.11	-0.7									-0.10	0.0	-0.11	+0.1
8	Groombridge 966					+0.18	+0.2	-0.08	+0.6					+0.03	0.0			-0.09	-0.2	0.05	+0.3
9	22 Camelopardalis			+1.09	-3.2	-2.51	-1.8	+3.04	+2.9					-0.43	0.0			-0.29	+0.3	-0.36	+1.5
10	51 Cephei			-0.31	[+5.2]	+0.46	-0.7	-0.09	-1.1					-0.01	-1.7			+0.01	+0.3	-0.05	-0.3
11	Piazzi VII. 67			-0.03	0.0			-0.05	-0.5						+0.4			-0.10	-0.2	-0.09	-0.3
12	3 Urse Majoris	+0.13	+1.4	-0.39	-1.4	-0.24	-1.7	-0.61	+1.8	0.00	-0.3	-0.1			-0.4			-0.07	+0.5	-0.05	+0.8
13	α^2 Urse Majoris	-0.20		-4.85	-0.5	+0.41	+1.0	-0.48	+0.6					+0.24	0.0			-0.22	-0.2	-0.06	+0.6
14	1 Draconis			-0.31	-4.3	-0.69	-0.3	+0.03	+0.6					+0.31	+0.1			-0.05	-0.4	-0.19	+0.1
15	24 Urse Majoris	+0.03	0.0	-0.12	+0.2	-0.69	-0.6	-0.08	-0.7					+0.08	-0.8			-0.13	-0.1	-0.05	0.0
16	32 Urse Majoris	0.00	-0.1	-0.08	+0.3	-0.65	+0.4	-0.03	+1.6					-0.10	-0.3			+0.03	+0.3	-0.04	+0.6
17	9 Draconis	+0.28	[-2.8]	-0.08	-1.3	-0.60	-1.5	-0.50	+0.4	-0.03	-0.1			-0.10	-0.3			0.00	+0.3	-0.27	+0.1
18	4 Draconis	-0.05	+0.1	-0.14	+1.3	+0.97	+0.7	-0.50	+0.4					+0.11	-0.1			+0.05	-0.3	-0.00	-0.1
19	α Draconis	-0.02	[-3.1]	+0.31	-0.3	+0.13	-0.2	-0.11	0.0	-0.01	+0.2			+0.46	0.0			-0.12	+0.5	-0.20	+0.2
20	32 Camelop. (fol.)	+0.22	0.0	-0.36	-0.5	-0.09	0.0	-0.59	-0.2	-0.08	-0.4			+0.02	-0.9			-0.02	-0.4	-0.05	+0.3
21	α Draconis	-0.25	[-4.2]	+1.68	+0.4	+0.32	+1.6	+0.22	+0.3					-0.10	-0.6			-0.01	-0.1	-0.05	0.0
22	2 Draconis	-0.21	[-3.3]	-0.33	-0.3	-0.09	-0.7	+0.18	+0.8	-0.10	-0.1	+0.02	0.0	-0.02	-0.9			+0.01	+0.3	-0.13	+0.4
23	5 Urse Minoris	-0.09	0.0	+0.04	+0.4	+0.85	-0.5	+0.05	+0.2	+0.07	-0.1	-0.01	-0.1	-0.10	-0.6			-0.11	+0.3	-0.05	+0.1
24	β Urse Minoris	+0.01	+0.6	-0.05	-1.0	-0.32	-2.2	-0.28	-0.5	+0.06	-0.2	-0.03	-0.1	-0.06	+0.2			+0.11	-0.3	-0.05	+0.1
25	γ^2 Urse Minoris	-0.29	[-2.9]	-0.17	-0.9	-0.35	+0.7	-0.26	-0.2	+0.10	+0.3	-0.03	+0.2	-0.15	-0.6			-0.20	-0.4	-0.05	-0.2
26	ξ Urse Minoris	-0.6	-0.6	+0.07	+1.3	-0.01	-0.8	-1.12	+0.3	-0.01	0.0	-0.07	+0.2	+0.10	-0.2			-0.05	-0.3	-0.18	-0.2
27	Groombridge 2320			-0.13	+3.8			+0.29	-0.1					-0.03	-0.2			-0.12	0.0	-0.15	+0.3
28	15 Draconis	-0.4	-0.4	-0.38	+3.3	+0.32	+1.6	+0.22	+0.3					+0.12	+0.1			-0.01	-0.1	-0.05	0.0
29	α Urse Minoris	-0.23	0.0	-0.76	-0.8	-1.49	+2.0	+0.14	+0.1	+0.01	0.0			-0.25	-0.1			+0.20	-0.2	-0.19	+0.1
30	ω Draconis	+0.05	0.0	-0.06	-0.7	-0.10	[+3.0]	-0.05	-1.2					+0.12	+0.2			-0.02	+1.3	-0.04	-1.1
31	ψ Draconis (pr.)	-0.27	-0.2	-0.52	-1.0	+0.19	+1.6	-0.14	+0.5	-0.15	+0.1	-0.02	-0.1	+0.23	-0.8			-0.08	-0.2	-0.04	0.0
32	δ Urse Minoris	-0.38	+0.4	+0.11	[+1.4]	-2.13	-0.2	+1.03	-0.6					+0.07	-6.8			-0.12	+0.1	-0.04	-0.1
33	50 Draconis	+0.18	-0.3	-0.25	[+4.4]	-1.18	+1.9	-0.22	-0.4	-0.57	0.0			-0.02	-0.1			+0.02	+1.3	-0.04	-1.1
34	δ Draconis	-0.12	-0.4	+0.17	+0.8	-0.01	0.0	+0.12	-0.7					-0.02	-0.1			-0.08	-0.2	-0.04	0.0
35	τ Draconis	-0.14	-0.2	-0.44	0.0	-0.13	+0.5	-0.01	-1.4					+0.07	-6.8			-0.02	+0.7	-0.07	0.0
36	α Draconis	+0.23	+0.1	-0.03	[-3.9]	-0.34	-1.4	+0.15	-0.8	-0.08	-0.3			-0.01	-0.1			-0.12	+0.1	-0.04	-0.1
37	λ Urse Minoris	-1.77	-0.1	-2.12	+0.1	-6.58	[-2.0]	-2.91	0.0					-0.02	-0.1			+0.08	-0.3	-0.16	+0.1
38	α Cephei	-0.14	+0.2	-0.27	-0.9	-2.55	-1.3	-0.18	-0.7	-1.03	-0.2	-0.46	0.0	-0.01	+0.5			-0.24	+0.2	-0.06	-0.3
39	Groombridge 3241			-0.25	+0.6	-0.21	-0.2	+0.96	+1.0					-0.05	+0.3			-0.70	-0.1	-0.45	+0.2
40	T. Y. C. 1879	+0.05	-0.2	+1.18	+0.2	-0.22	-2.6	+1.71	-0.8	+0.02	-0.2	+0.03	0.0	-0.01	-0.1			-0.23	+0.1	-0.18	-0.1
41	β Cephei	-0.08	+0.2	-0.02	[+2.8]	-0.58	-2.0	-0.05	-0.7					-0.01	-0.1			-0.14	+0.1	-0.05	-0.2
42	11 Cephei	-0.36	+0.1	-0.10	-1.0	-0.21	-0.3	+0.15	+0.8					-0.01	+0.1			-0.07	+0.2	0.00	+0.2
43	79 Draconis	+0.26	-0.1	-0.16	+0.6	-0.21	-0.2	+0.05	+0.3					-0.02	-0.4			-0.32	+0.4	-0.31	-0.8
44	226 Cephei			-0.28	-0.4	-0.15	-0.3	+0.15	+0.8					-0.03	+0.3			+0.15	+0.3	-0.15	-0.3
45	ϵ Cephei	+0.08	-0.3	-0.01	+1.0	-0.15	-0.3	+0.05	+0.8	+0.01	0.0	-0.01	0.0	+0.25	+0.8			+0.10	-0.1	-0.08	+0.1
46	σ Cephei	-0.01	[-3.5]	-0.20	+1.0	-0.07	+0.1	+0.05	+0.3	-0.08	-0.3			-0.05	+0.3			-0.08	+0.2	-0.09	+0.1
47	γ Cephei	-0.05	-0.6	+0.27	-0.4	-0.41	-1.0	+0.22	-0.1	-0.05	+0.1	0.00	+0.3	+0.07	+0.4			-0.08	-0.2	-0.12	-1.3
48	Groombridge 4163			-0.23	-0.6	-0.19	[-1.4]	-0.19	[-1.4]					+0.33	+0.1			-0.08	-0.2	-0.33	-0.1
	Mean Difference	+0.08	0.0	-0.01	0.0	-0.01	+0.1	-0.06	0.0	0.00	-0.1	0.00	+0.1	+0.01	-0.1			0.00	+0.1	-0.02	0.0
	Mean Discordance	± 0.17	± 0.4	± 0.29	± 0.9	± 0.42	± 1.3	± 0.36	± 0.8	± 0.08	± 0.2	± 0.04	± 0.2	± 0.16	± 0.5			± 0.13	± 0.4	± 0.14	± 0.5

OBSERVED RIGHT-ASCENSIONS OF FOUR POLAR STARS.

Date.	Authority.	<i>Polaris.</i>		<i>51 Cephei.</i>		<i>δ Ursæ Minoris.</i>		<i>λ Ursæ Minoris.</i>	
		Observed.	Reduced 1850.0.	Observed.	Reduced 1850.0.	Observed.	Reduced 1850.0.	Observed.	Reduced 1850.0.
		^h ^m ^s	^h ^m ^s	^h ^m ^s	^h ^m ^s	^h ^m ^s	^h ^m ^s	^h ^m ^s	^h ^m ^s
1755	Bradley	0 43 42.29	1 4 53.57			18 50 36.29	18 20 40.35	21 17 41.54	20 12 65.27
1790	Lalande	50 18.51	4 55.86	5 57 37.97	6 28 40.17	39 47.26	20 41.84	20 58 2.38	12 66.71
1800	Piazzi	52 25.30	4 60.06	6 2 42.95	28 35.51	36 35.07	20 39.89	51 22.80	12 57.30
1810	Groombridge	51 37.56	4 59.86	7 58.61	28 40.00	33 28.63	20 43.33	44 41.23	12 66.08
1815	Struve	55 48.68	4 57.23					41 8.50	12 61.78
1820	Struve	57 1.58	4 58.67						
1824	Struve	58 0.24	4 58.71			29 2.30	20 42.14		
1824	Bessel					29 2.77	20 42.68		
1828	Struve	59 2.26	4 60.56						
1830	Argelander							29 46.60	12 61.29
1830	Pond	0 59 31.16	4 58.84	18 15.86	28 33.40	27 8.34	20 43.10		
1835	Taylor			20 52.10	28 34.89			25 44.66	12 60.04
1840	Airy	1 2 11.12	4 59.96	23 25.44	28 33.45	23 56.36	20 43.25	21 39.23	12 62.13
1840	Johnson	2 11.88	4 60.82			23 56.43	20 43.42	21 38.16	12 61.16
1841	Airy	2 27.39	4 59.81	23 57.36	28 34.50	23 37.18	20 43.33	20 50.82	12 64.11
1841	Johnson	2 28.64	4 61.15	23 56.61	28 33.84	23 37.01	20 43.25		
1842	Airy	2 43.62	4 59.53	24 27.12	28 33.70	23 17.76	20 43.19	19 58.28	12 62.26
1842	Johnson	2 45.32	4 61.31	24 27.39	28 33.76	23 17.94	20 43.45	19 58.25	12 62.32
1843	Airy	3 0.79	4 60.16	24 55.81	28 31.35	22 59.00	20 43.80	19 7.51	12 62.55
1843	Johnson	3 2.22	4 61.58	24 57.75	28 33.25	22 59.16	20 43.96	19 5.50	12 60.54
1844	Airy	3 17.37	4 59.99	25 28.07	28 32.73	22 39.41	20 43.47	18 11.81	12 58.09
1844	Johnson	3 18.20	4 60.83	25 28.27	28 32.95	22 39.33	20 43.41		
1845	Airy	3 34.45	4 60.24	25 59.02	28 32.86	22 19.83	20 43.20		
1845	Johnson	3 35.42	4 61.21	25 59.45	28 33.29	22 20.11	20 43.48		
1846	Airy	3 51.16	4 59.96	26 28.55	28 31.54	22 0.10	20 42.73	16 32.08	12 61.71
1846	Johnson	3 52.59	4 61.43	26 30.34	28 33.37	22 0.84	20 43.51	16 29.87	12 59.53
1847	Airy	4 9.36	4 61.11	26 58.98	28 31.18	21 41.33	20 43.28	15 39.09	12 60.86
1847	Johnson	4 10.00	4 61.77	27 1.46	28 33.68	21 41.14	20 43.11	15 37.75	12 59.54
1848	Airy	4 25.99	4 60.61	27 30.95	28 32.41	21 21.40	20 42.70	14 45.90	12 60.13
1848	Johnson	4 26.62	4 61.22	27 32.11	28 33.55	21 21.78	20 43.05	14 44.98	12 59.18
1849	Airy	4 43.87	4 61.14	28 2.29	28 32.92	21 3.46	20 44.01	13 53.54	12 60.42
1849	Johnson			28 3.05	28 33.72	21 2.81	20 43.40	13 52.46	12 59.38
1850	Airy	5 0.80	4 60.67	28 33.09	28 32.96	20 43.76	20 43.63	13 2.25	12 62.12
1850	Johnson	5 1.22	4 61.13	28 33.40	28 33.31	20 43.42	20 43.32		
1851	Airy	5 19.02	4 61.38	29 3.82	28 32.95	20 24.11	20 43.31	12 7.80	12 60.96
1851	Johnson	5 18.30	4 60.69	29 3.83	28 33.00	20 24.08	20 43.32	12 6.73	12 59.92
1852	Airy	5 36.75	4 61.48	29 33.58	28 31.98	20 5.10	20 43.63	11 13.64	12 60.39
1852	Johnson	5 36.95	4 61.72	29 34.50	28 32.93	20 4.80	20 43.36	11 12.76	12 59.55
1853	Airy	5 54.65	4 61.63	30 5.80	28 33.49	19 45.66	20 43.53	10 21.13	12 61.76
1853	Johnson			30 5.49	28 33.21	19 45.82	20 43.72	10 19.09	12 59.75
1854	Airy	1 6 12.98	1 4 62.10	30 36.15	28 33.14	19 25.79	20 43.00	20 9 24.97	20 12 59.78
1854	Johnson			6 30 35.92	6 28 32.95	18 19 26.46	18 20 43.71		

SOLUTION OF EQUATIONS.

NAME.	α		μ		α 1855.0.
	^h ^m ^s	^s	^s	^s	^h ^m ^s
Polaris	1 5 1.15	±0.04	+0.0729	±0.0015	1 6 30.26
51 Cephei	6 28 32.80	±0.07	−0.1062	±0.0033	6 31 5.84
δ Ursæ Minoris	18 20 43.48	±0.02	+0.0285	±0.0007	18 19 6.93
λ Ursæ Minoris	20 13 0.43	±0.09	−0.0707	±0.0029	20 8 30.66

SYNOPTICAL TABLE FOR RIGHT-ASCENSIONS OF FOUR POLAR STARS.

Date.	Authority.	<i>Polaris.</i>		<i>51 Cephei.</i>		<i>δ Ursæ Minoris.</i>		<i>λ Ursæ Minoris.</i>	
		<i>α</i>	<i>Δα</i>	<i>α</i>	<i>Δα</i>	<i>α</i>	<i>Δα</i>	<i>α</i>	<i>Δα</i>
		^h ^m ^s	^s	^h ^m ^s	^s	^h ^m ^s	^s	^h ^m ^s	^s
1755	Bradley	1 6 29.61	—0.58			18 19 6.51	—0.38	20 8 28.79	—1.77
1790	Lalande	29.34	—0.85	6 31 6.83	+1.06	7.00	+0.11	32.68	+2.12
1800	Piazzi	32.81	+2.62	3.23	—2.51	[4.76]	[—2.13]	[23.98]	[—6.58]
1810	Groombridge	31.89	+1.70	8.78	+3.04	7.92	+1.03	33.47	+2.91
1815	Struve	28.89	—1.30					29.53	—1.03
1820	"	29.97	—0.22						
1824	"	29.72	—0.47			6.32	—0.57		
1828	"	31.27	+1.08						
1824	Bessel					6 87	—0.02		
1830	Argelander							30.10	—0.46
1830	Pond	29.41	—0.78	4.31	—1.43	7.12	+0.23		
1835	Taylor			6.32	+0.58			29.21	—1.35
1840	Airy	29.80	—0.39	5.42	—0.32	6.99	+0.10	31.65	+1.09
1841	"	29.58	—0.61	6.57	+0.83	7.04	+0.15	33.70	+3.14
1842	"	29.22	—0.97	5.87	+0.13	6.87	—0.02	31.92	+1.36
1843	"	29.78	—0.41	3.64	—2.10	7.45	+0.56	32.28	+1.72
1844	"	29.54	—0.65	5.11	—0.63	7.09	+0.20	27.89	—2.67
1845	"	29.71	—0.48	5.35	—0.39	6.79	—0.10		
1846	"	29.36	—0.83	4.14	—1.60	6.29	—0.60	31.66	+1.10
1847	"	30.44	+0.25	3.89	—1.85	6.82	—0.07	30.88	+0.32
1848	"	29.87	—0.32	5.22	—0.52	6.21	—0.68	30.22	—0.34
1849	"	30.32	+0.13	5.84	+0.10	7.49	+0.60	30.58	+0.02
1850	"	29.78	—0.41	5.99	+0.25	7.08	+0.19	32.35	+1.79
1851	"	30.42	+0.23	6.08	+0.34	6.73	—0.16	31.26	+0.70
1852	"	30.44	+0.25	5.22	—0.52	7.02	+0.13	30.76	+0.20
1853	"	30.52	+0.33	6.84	+1.10	6.89	0.00	32 20	+1.64
1854	"	30.92	+0.73	6.59	+0.85	6.32	—0.57	30.29	—0.27
1840	Johnson	30.66	+0.47			7.16	+0.27	30.68	+0.12
1841	"	30.92	+0.73	5.91	+0.17	6.96	+0.07		
1842	"	31.00	+0.81	5.93	+0.19	7.13	+0.24	31.98	+1.42
1843	"	31.20	+1.01	5.54	—0.20	7.61	+0.72	30.27	—0.29
1844	"	30.38	+0.19	5.31	—0.43	7.03	+0.14		
1845	"	30.68	+0.49	5.78	+0.04	7.07	+0.18		
1846	"	30.83	+0.64	5.97	+0.23	7.07	+0.18	29.48	—1.08
1847	"	31.10	+0.91	6.39	+0.65	6.65	—0.24	29.56	—1.00
1848	"	30.48	+0.29	6.36	+0.62	6.56	—0.33	29.27	—1.29
1849	"			6.64	+0.90	6.88	—0.01	29.54	—1.02
1850	"	30.24	+0.05	6.36	+0.62	6.77	—0.12		
1851	"	29.73	—0.46	6.13	+0.39	6.74	—0.15	30.22	—0.34
1852	"	1 6 30.68	+0.49	6.17	+0.43	6.75	—0.14	29.92	—0.64
1853	"			6.56	+0.82	7.08	+0.19	20 8 30.19	—0.37
1851	"			6 31 6.40	+0.66	18 19 7.03	+0.14		
Mean		1 6 30.19	±0.111	6 31 5.74	±0.149	18 19 6.89	±0.057	20 8 30.56	±0.24

MEAN OF OBSERVATIONS.

	<i>Polaris.</i>	<i>51 Cephei.</i>	<i>δ Ursæ Minoris.</i>	<i>λ Ursæ Minoris.</i>
	^h ^m ^s	^h ^m ^s	^h ^m ^s	^h ^m ^s
The mean of STRUVE's Observations gives	1 6 29.96		18 19 6.32	20 8 29.53
" AIRY'S " "	1 6 29.98	6 31 5.45	18 19 6.87	20 8 31.26
" JOHNSON'S " "	1 6 30.66	6 31 6.10	18 19 6.97	20 8 30.11

The average differences and discordances from the adopted mean are : —

	<i>Polaris.</i>		<i>51 Cephei.</i>		<i>δ Ursæ Minoris.</i>		<i>λ Ursæ Minoris.</i>	
	Difference.	Discordance.	Difference.	Discordance.	Difference.	Discordance.	Difference.	Discordance.
STRUVE	^s −0.23	^s ±1.02	^s −0.29	^s ±1.01	^s −0.57	^s ±0.38	^s −1.03	^s ±1.54
AIRY	−0.21	±0.54	−0.29	±1.01	−0.02	±0.38	+0.70	±1.54
JOHNSON	+0.47	±0.64	+0.36	±0.54	+0.08	±0.27	−0.45	±0.92

To facilitate the reduction of the places thus obtained to any other mean equinox, the coefficients of the several significant terms of the precession have been computed, and are incorporated in the tables of resultant values, upon the two following pages ; so that the mean place for any date t is,

$$\alpha' = \alpha + (\mu + A) t + Bt^2 + Ct^3 + \&c.$$

$$\delta' = \delta + (\mu' + A') t + B't^2 + C't^3 + \&c.$$

And for convenience of reduction to the apparent equinox of any date, the constants $a, b, c, d, a', b', c', d'$ have been computed for each of the years 1855 and 1865.

For the following stars the terms containing the fourth or higher powers of the time become appreciable within a century : —

<i>Polaris.</i>	<i>51 Cephei.</i>	<i>λ Ursæ Minoris.</i>	<i>δ Ursæ Minoris.</i>
A +18.0464	A +30.6746	A −54.6200	A −19.3527
B + 0.060321	B − 0.0079 17	B − 0.1477 78	B − 0.0027 62
C + 0.0002 1167	C − 0.0000 4121	C − 0.0000 7653	C + 0.0000 1561
D + 0.0000 007128	D + 0.0000 000349	D + 0.0000 014451	D + 0.0000 0000 64
E + 0.0000 0000 2288	E + 0.0000 0000 0097	E + 0.0000 0000 7277	E − 0.0000 0000 0019
F + 0.0000 0000 000697	F − 0.0000 0000 0000 14	F + 0.0000 0000 0007 11	F − 0.0000 0000 0000 01
G + 0.0000 0000 0000 0193		G − 0.0000 0000 0000 1158	
H + 0.0000 0000 0000 0000 40		H − 0.0000 0000 0000 0002 12	
A' +19.217	A' −2.7131	A' +10.666	A' +1.671
B' − 0.00382	B' −0.02208	B' − 0.03379	B' −0.01404
C' − 0.0000 139	C' +0.0000 062	C' − 0.0000 889	C' −0.0000 019
D' − 0.0000 00049	D' +0.0000 00023	D' − 0.0000 00092	D' +0.0000 0000 8
E' − 0.0000 0000 018	E' −0.0000 0000 002	E' + 0.0000 0000 052	
F' − 0.0000 0000 0000 6		F' + 0.0000 0000 0002 5	
G' − 0.0000 0000 0000 001		G' − 0 0000 0000 0000 005	
H' − 0.0000 0000 0000 0000 1			

32 Camelopardalis.

A +0.3279
B +0.001171
C −0.0000 0109
D +0.0000 0000 10
E −0.0000 0000 0001

ε Ursæ Minoris.

A −6.4519
B +0.0015 03
C +0.0000 0060
D −0.0000 0000 04

21 Cassiopeæ.

A +3.8138
B +0.0007 91
C +0.0000 0026
D +0.0000 0000 01

1 Draconis.

A +9.2816
B −0.0040 61
C +0.0000 0135
D +0.0000 0000 02

9 Draconis.

A +5.3597
B −0.001426
C +0.0000 0046
D −0.0000 0000 01

4 Draconis.

A +2.9194
B −0.0006 45
C +0.0000 0032
D −0.0000 0000 01

T. Y. C. 1879.

A −2.4316
B −0.0015 18
C −0.0000 0048
D −0.0000 0000 01

48 Cephei.

A +7.2695
B +0.0017 51
C +0.0000 0021
D −0.0000 0000 02

RIGHT-ASCENSIONS.

No.	NAME.	δ $^{\circ}$	A $^{\circ}$	100 B $^{\circ}$	100 C $^{\circ}$	μ $^{\circ}$	a		b		c		d	
							1855.	1865.	1855.	1865.	1855.	1865.	1855.	1865.
1	21 Cassiopeæ	0 36 8.47	+ 3.8138	+ 0.0791	+ 0.000026	- 0.0326	9.38330	9.38458	8.58486	8.59386	0.58136	0.58316	9.36656	9.36795
2	Polaris	1 6 30.19	18.0164	6.0321	0.021167	+ 0.0729	0.39814	0.41211	9.87325	9.90863	1.25610	1.28591	0.39800	0.41231
3	4 Cassiopeæ	1 20 30.66	4.3035	0.0704	0.000015	+ 0.0246	9.23554	9.25310	8.81662	8.82137	0.63383	0.63525	9.22118	9.22188
4	50 Cassiopeæ	1 51 8.59	4.9583	0.0923	0.000019	- 0.0092	9.27416	9.27416	8.99591	9.00000	0.69531	0.69696	9.25166	9.25208
5	1 Cassiopeæ	2 17 10.57	4.8251	0.0651	0.000008	- 0.0094	9.11160	9.11136	8.97839	8.98143	0.68350	0.68464	9.10781	9.10772
6	48 Cephei	3 2 5.38	7.2695	0.1751	+ 0.000021	+ 0.0032	9.32375	9.32269	9.33170	9.33521	0.86150	0.86359	9.31281	9.31182
7	4 Camelopardalis	4 39 39.60	5.9042	0.0353	- 0.000011	- 0.0088	8.75192	8.74710	9.18887	9.18987	0.77116	0.77168	8.71295	8.70820
8	Groombridge 966	5 20 21.76	7.9661	+ 0.0410	0.000043	+ 0.0084	8.64486	8.63046	9.10262	9.10332	0.90121	0.90168	8.62968	8.61530
9	22 Camelopardalis	6 2 51.55	6.6217	- 0.0015	0.000022	- 0.0013	9.737323	9.751485	9.27677	9.27672	0.82097	0.82095	9.731413	9.748605
10	51 Cephei	6 31 5.74	30.6746	0.7917	0.000121	- 0.1062	9.27411	9.33861	0.13649	0.13649	1.48678	1.48432	9.27391	9.33811
11	Piazzi VII. 67.	7 15 45.09	6.3247	0.0406	0.000015	+ 0.0084	9.77601	9.78145	9.24059	9.23951	0.80104	0.80048	9.74517	9.75083
12	3 Ursæ Majoris	7 58 19.42	6.0844	0.0391	- 0.000007	+ 0.0074	9.896092	9.896375	9.20685	9.20522	0.78422	0.78338	9.83076	9.83351
13	3 Ursæ Majoris	8 57 34.30	5.4035	0.0670	+ 0.000003	- 0.0024	9.08992	9.09093	9.09912	9.09672	0.96762	0.96382	9.55177	9.55198
14	1 Draconis	9 16 1.12	9.2816	0.4061	0.000135	- 0.0786	9.55606	9.55531	9.49512	9.48847	0.96762	0.96382	9.55177	9.55198
15	24 Ursæ Majoris	9 21 34.97	5.4739	0.0359	0.000010	- 0.0081	9.18638	9.18688	9.10109	9.10107	0.73830	0.73693	9.16063	9.16101
16	32 Ursæ Majoris	10 7 26.88	4.4768	0.0382	0.000009	- 0.0161	9.15708	9.15700	8.85527	8.85179	0.65097	0.64984	9.11723	9.11699
17	9 Draconis	10 22 38.72	5.3597	0.1426	0.000046	+ 0.0014	9.41398	9.41314	9.06943	9.06408	0.72681	0.72681	9.40174	9.40081
18	4 Draconis	11 22 44.62	3.6706	0.0369	0.000016	- 0.0093	9.28682	9.28586	8.50167	8.49340	0.56474	0.56340	9.26017	9.25905
19	4 Draconis	12 5 20.95	2.9194	0.0645	0.000032	+ 0.0067	9.52125	9.51917	9.78977	9.79252	0.46530	0.46340	9.51232	9.51016
20	2 Draconis	12 27 16.06	2.6215	- 0.0279	+ 0.000009	- 0.0124	9.29922	9.29792	9.83767	9.838245	0.41854	0.41762	9.27380	9.27236
21	32 Camelop. (foll.)	12 48 7.15	0.3279	+ 0.1160	- 0.000108	- 0.0123	9.80978	9.80572	9.13836	9.13482	9.51576	9.54506	9.80756	9.80315
22	5 Draconis	14 0 27.84	1.6286	0.0024	0.000000	- 0.0080	9.13611	9.13503	9.89598	9.89969	0.21194	0.21194	9.09363	9.09238
23	5 Ursæ Minoris	14 27 53.10	0.2370	0.0615	0.000019	+ 0.0031	9.35323	9.35190	9.22990	9.22473	9.37483	9.35180	9.31077	9.33934
24	3 Ursæ Minoris	14 51 10.43	0.2595	0.0519	0.000013	- 0.0078	9.26943	9.26837	9.23595	9.23473	9.41410	9.38763	9.25385	9.25271
25	7 Ursæ Minoris	15 20 59.52	0.1589	0.0380	0.000007	+ 0.0004	9.14799	9.14720	9.22500	9.22712	9.20116	9.17993	9.12705	9.12618
26	7 Ursæ Minoris	15 49 19.82	- 2.3310	0.1026	0.000017	+ 0.0067	9.21681	9.21686	9.43981	9.43828	9.36811	9.36429	9.23759	9.23759
27	Groombridge 2320	16 5 56.49	+ 0.1356	0.0206	0.000002	- 0.0095	9.83283	9.83224	9.19780	9.19732	9.13222	9.14530	9.89005	9.89992
28	15 Draconis	16 28 17.18	- 0.1498	0.0207	- 0.000002	+ 0.0015	9.86146	9.86146	9.23545	9.23500	9.17549	9.16336	9.83217	9.83178
29	5 Ursæ Minoris	17 0 59.06	6.4519	0.1503	+ 0.000060	+ 0.0092	9.10110	9.10791	9.68053	9.67918	9.08069	9.08076	9.09713	9.10396
30	5 Draconis	17 37 48.23	0.3634	0.0069	0.000000	+ 0.0041	9.825154	9.825262	9.26408	9.26396	9.56037	9.55871	9.82118	9.82224
31	5 Ursæ Minoris (pr.)	17 44 31.39	1.0878	+ 0.0077	0.000002	- 0.0016	9.16823	9.17318	9.33808	9.33796	9.03656	9.03594	9.81469	9.815192
32	5 Ursæ Minoris	18 19 6.89	19.3527	- 0.2762	0.001561	+ 0.0285	8.97152	8.9185	9.04925	9.05026	9.128789	9.128789	8.97076	8.97076
33	50 Draconis	18 51 1.52	- 1.8846	0.0273	+ 0.000003	- 0.0125	8.76228	8.75999	9.40746	9.40795	9.27521	9.27521	8.74771	8.74517
34	5 Draconis	19 12 30.59	+ 0.0182	0.0113	- 0.000001	+ 0.0199	8.73231	8.73264	9.21725	9.21756	8.26102	8.26102	8.69763	8.69801
35	1 Draconis	19 18 18.81	- 1.0704	0.0281	0.000001	- 0.0337	8.88524	8.88175	9.33120	9.33178	9.02954	9.02954	8.86603	8.86559
36	5 Ursæ Minoris	19 48 38.45	0.1786	0.0218	0.000002	+ 0.0142	8.94717	8.94759	9.23700	9.23756	9.25188	9.25188	8.91987	8.92036
37	2 Ursæ Minoris	20 8 30.56	5.16200	14.7778	0.007653	- 0.0707	9.25692	9.25692	9.45897	9.45897	9.1736	9.1736	9.25684	9.25850
38	2 Ursæ Minoris	20 13 41.20	1.8691	0.0817	0.000014	- 0.0007	9.22187	9.22200	9.40337	9.40379	9.27164	9.27164	9.21106	9.21124
39	Groombridge 3241	20 30 35.74	0.1911	0.0332	0.000006	- 0.0096	9.12079	9.12150	9.23316	9.23430	9.28798	9.28798	9.09910	9.09989
40	T. Y. C. 1879	20 54 1.09	- 2.1316	0.1518	0.000048	- 0.0039	9.42235	9.42319	9.44503	9.44743	9.038590	9.038590	9.41571	9.41658
41	5 Ursæ Minoris	21 26 46.30	+ 0.8040	0.0170	0.000001	+ 0.0018	9.18299	9.18410	9.08059	9.08118	9.90529	9.90529	9.15577	9.15699
42	11 Cephei	21 39 46.99	0.8859	0.0161	0.000004	+ 0.0273	9.21650	9.21778	9.09367	9.09326	9.94740	9.94740	9.19133	9.19263
43	79 Draconis	21 51 3.71	0.7370	0.0230	0.000006	+ 0.0092	9.28567	9.28699	9.08539	9.08619	9.86746	9.86746	9.26630	9.26773
44	226 Cephei	22 29 42.59	1.0962	- 0.0164	+ 0.000003	- 0.0071	9.39177	9.39177	9.00890	9.00957	0.03748	0.03748	9.37602	9.37777
45	1 Cephei	22 41 31.61	2.1257	+ 0.0110	- 0.000006	+ 0.0124	9.18117	9.18228	9.871489	9.871380	0.32751	0.32751	9.13999	9.14127
46	6 Cephei	23 12 41.11	2.4161	0.0198	0.000005	+ 0.0165	9.22845	9.22960	9.54945	9.54678	0.38312	0.38312	9.19349	9.19481
47	7 Cephei	23 33 25.89	2.4113	0.0365	0.000016	- 0.0195	9.46312	9.46500	9.52925	9.52445	0.38225	0.38225	9.45153	9.45351
48	Groombridge 4163	23 47 49.63	+ 2.8307	+ 0.0434	+ 0.000015	- 0.0015	9.37261	9.37412	9.809803	9.808228	0.45190	0.45190	9.35161	9.35621

DECLINATIONS.

No.	NAME.	δ	A'	$100V'$	$100V$	μ'	a'		b'		c'		d'	
							1855.	1865.	1855.	1865.	1855.	1865.	1855.	1865.
1	21 Cassiopeæ	74 11' 39.0	+19.807	-0.048	-0.00003	-0.059	n8.51783	n8.55678	9.97783	9.97776	1.29682	1.29661	n9.19614	n9.20367
2	2 Polaris	88 32' 11.2	19.217	0.382	0.00139	+0.006	n9.43926	n9.45991	9.98131	9.97952	1.28370	1.28187	n9.45656	n9.47583
3	A Cassiopeæ	69 30' 58.3	18.831	0.112	0.00001	-0.079	n9.23172	n9.23992	9.91426	9.91439	1.27488	1.27436	n9.53671	n9.51010
4	50 Cassiopeæ	71 42' 58.6	17.743	0.172	0.00006	-0.000	n9.48643	n9.49139	9.92430	9.92359	1.24904	1.24819	n9.66854	n9.67151
5	1 Cassiopeæ	66 44' 48.0	16.569	0.202	0.00005	-0.019	n9.53953	n9.54349	9.88027	9.87937	1.21930	1.21824	n9.75085	n9.75308
6	48 Cephei	77 11' 40.0	14.051	0.381	0.00013	-0.061	n9.77788	n9.78078	9.83451	9.83225	1.14772	1.14534	n9.85312	n9.85567
7	Camelopardalis	66 5' 21.0	6.887	0.406	0.00004	+0.009	n9.83423	n9.83525	9.19683	9.19176	0.83801	0.83289	n9.97275	n9.97343
8	Groombidge 966	74 56' 14.9	3.451	0.573	-0.00001	-0.002	n9.92349	n9.92401	9.22053	9.22058	0.53796	0.52327	n9.99347	n9.99391
9	22 Camelopardalis	69 21' 44.7	-0.250	0.483	+0.00000	-0.109	n9.89366	n9.89362	n8.06762	n8.20929	n9.39867	n9.51032	n9.99997	n9.99994
10	51 Cephei	87 15' 8.3	2.713	2.208	0.00062	+0.002	n9.98626	n9.98177	n9.13072	n9.19618	n0.43347	n0.49891	n9.99599	n9.99456
11	Piazzi VII. 67	68 45' 15.1	6.509	0.435	0.00004	-0.073	n9.85991	n9.85896	n9.48071	n9.48613	n0.81353	n0.81928	n9.97583	n9.97514
12	3 Urse Majoris	68 53' 39.4	9.901	0.384	0.00007	-0.011	n9.61628	n9.61471	n9.66326	n9.66655	n0.99566	n0.99901	n9.93335	n9.93825
13	a ² Urse Majoris	67 43' 5.0	14.031	0.279	0.00006	-0.095	n9.69606	n9.69344	n9.81113	n9.81275	n1.14708	n1.14880	n9.85104	n9.85236
14	1 Draconis	81 57' 38.3	15.138	0.441	0.00025	+0.005	n9.76999	n9.76598	n9.87353	n9.87601	n1.18007	n1.18257	n9.81688	n9.81350
15	24 Urse Majoris	70 27' 48.6	15.452	0.251	0.00007	+0.050	n9.65864	n9.65514	n9.86100	n9.86231	n1.18900	n1.19010	n9.80147	n9.80237
16	32 Urse Majoris	65 49' 45.0	17.686	0.150	0.00001	-0.035	n9.40238	n9.39699	n9.90553	n9.90612	n1.24762	n1.24836	n9.67356	n9.67091
17	9 Draconis	76 27' 26.7	18.274	0.157	0.00008	-0.030	n9.47575	n9.47005	n9.91733	n9.91800	n1.26182	n1.26256	n9.61503	n9.61128
18	4 Draconis	70 7' 50.2	19.792	-0.039	0.00003	-0.059	n7.67389	n7.25814	n9.96758	n9.96762	n1.29648	n1.29665	n9.20909	n9.20197
19	1 Draconis	78 25' 18.8	20.050	+0.009	0.00001	-0.008	9.04128	9.05095	n9.99095	n9.99084	n1.30243	n1.30208	8.36840	8.40610
20	2 Draconis	70 35' 16.1	19.914	0.027	0.00001	-0.021	9.40855	9.41215	n9.97150	n9.97125	n1.29916	n1.29904	9.07448	9.08134
21	32 Camelop. (coll.)	84 12' 3.7	19.616	0.009	0.00001	-0.021	9.40001	9.40109	n9.98813	n9.98806	n1.29260	n1.29256	9.31893	9.31914
22	2 Draconis	65 4' 11.0	17.319	+0.063	0.00000	-0.031	9.80476	9.80549	n9.89454	n9.89407	n1.23926	n1.23895	9.70049	9.70138
23	5 Urse Minoris	76 20' 25.3	16.023	-0.007	0.00002	-0.020	9.83689	9.83694	n9.89005	n9.89002	n1.20175	n1.20179	9.77909	9.77909
24	3 Urse Minoris	74 41' 52.3	14.717	0.010	0.00002	-0.029	9.88626	9.88628	n9.85001	n9.85000	n1.16782	n1.16788	9.83210	9.83201
25	2 ² Urse Minoris	72 21' 0.1	12.825	0.006	0.00001	+0.028	9.93662	9.93663	n9.78487	n9.78485	n1.10806	n1.10810	9.88579	9.88579
26	5 Urse Minoris	78 14' 18.0	10.825	-0.141	0.00005	-0.003	9.96028	9.95992	n9.72297	n9.72407	n1.03443	n1.03556	9.92522	9.92475
27	Groomb. 2320	68 11' 32.5	9.574	+0.011	0.00001	+0.070	9.98990	9.98993	n9.64662	n9.64646	n0.98111	n0.98101	9.94384	9.94386
28	15 Draconis	69 4' 51.3	7.813	-0.008	0.00001	+0.031	0.00656	0.00655	n9.56098	n9.56102	n0.89283	n0.89292	9.96426	9.96421
29	2 Urse Minoris	82 16' 6.7	5.108	0.454	0.00009	+0.001	0.00715	0.00668	n9.40204	n9.40967	n0.70825	n0.71588	9.98514	9.98490
30	2 Draconis	68 49' 27.0	1.939	0.026	0.00000	+0.292	0.03536	0.03536	n8.95506	n8.95623	n0.28767	n0.28883	9.99796	9.99795
31	2 ² Draconis (pr.)	72 13' 7.4	-1.353	0.079	+0.00000	-0.261	0.03446	0.03444	n8.80791	n8.81294	n0.13141	n0.13643	9.99801	9.99899
32	5 Urse Minoris	86 35' 58.0	+1.671	1.401	-0.00019	+0.018	0.00882	0.00926	8.92000	8.82978	0.22300	0.14277	9.99849	9.99896
33	50 Draconis	75 15' 37.3	4.428	0.135	0.00001	+0.058	0.02269	0.02279	9.32943	9.32681	0.64621	0.64355	9.98915	9.98928
34	1 Draconis	67 24' 23.2	6.240	0.000	0.00001	+0.068	0.01876	0.01875	9.45827	9.45834	0.79519	0.79519	9.97789	9.97789
35	7 Draconis	73 5' 5.3	6.721	0.075	0.00001	+0.098	0.01186	0.01194	9.50597	9.50506	0.82742	0.82645	9.97414	9.97426
36	2 Draconis	69 53' 54.0	9.155	0.014	0.00001	-0.001	9.99329	9.99329	9.63213	9.63209	0.96168	0.96155	9.94926	9.94929
37	2 Urse Minoris	88 52' 32.2	10.666	3.379	0.00889	+0.015	9.93207	9.94250	9.72568	9.69613	1.02801	0.99844	9.92781	9.93844
38	2 Cephei	77 16' 20.7	11.017	0.116	0.00004	-0.001	9.95891	9.95920	9.73019	9.72934	1.04324	1.04232	9.92150	9.92189
39	Groomb. 3211	72 2' 24.8	12.251	0.014	0.00001	-0.022	9.94791	9.94790	9.76423	9.76423	1.08817	1.08807	9.89859	9.89864
40	T. Y. C. 1879	80 0' 20.9	13.807	-0.132	0.00006	-0.049	9.89742	9.89797	9.83121	9.83044	1.14009	1.13926	9.86053	9.86126
41	3 Cephei	69 55' 28.5	15.738	+0.033	0.00001	-0.038	9.86402	9.86367	9.86748	9.86780	1.19635	1.19713	9.79230	9.79198
42	11 Cephei	70 38' 39.1	16.418	0.031	0.00001	+0.072	9.83613	9.83570	9.88782	9.88813	1.21533	1.21551	9.75916	9.75876
43	79 Draconis	73 1' 0.0	16.965	0.025	0.00001	-0.009	9.80405	9.80360	9.90791	9.90820	1.22955	1.22968	9.72703	9.72666
44	226 Cephei	75 28' 45.6	18.520	0.027	0.00001	-0.010	9.68159	9.68068	9.95129	9.95153	1.26763	1.26776	9.58416	9.58334
45	1 Cephei	65 26' 18.4	18.978	0.046	0.00001	-0.141	9.67624	9.67479	9.93482	9.93523	1.27826	1.27847	9.50976	9.50776
46	2 Cephei	67 19' 6.3	19.630	0.032	0.00001	-0.019	9.55199	9.55199	9.95572	9.95572	1.29292	1.29306	9.31468	9.30802
47	7 Cephei	76 49' 23.7	19.921	0.016	0.00001	+0.148	9.32540	9.32110	9.98549	9.98567	1.29932	1.29939	9.06321	9.05661
48	Groomb. 4163	73 36' 12.3	+20.028	+0.007	-0.00001	-0.030	9.23903	9.23804	9.98136	9.98153	1.30161	1.30166	8.72478	8.70759

These tables of right-ascension and declination will, I trust, leave little to be desired for purposes connected with the determination of instrumental corrections and adjustments. Taken in connection with the coefficients given on page 77, they may be used for the time of BRADLEY without hesitation. The computations were chiefly made during the years 1855 and 1856, and the resulting right-ascensions have been employed since then in the telegraph work of the Survey; but their arrangement in a form fit for presentation has been delayed until recently by pressure of other work and by numerous adverse circumstances. In the numerical computations I have been assisted by Mr. JAMES H. TOOMER, who has devoted to the work great care and assiduity, and to whose exactitude whatever precision the results may possess is in great measure due.

NOTE. — The printing of this report, commenced in Albany in January last, has been interrupted and delayed by causes not within the control of the author, as also by the loss or destruction of a portion of the manuscript.

NOTE ON AN INEQUALITY OF LONG PERIOD BETWEEN THE PLANETS MARS AND JUNO.

By SIMON NEWCOMB.

THE ratio of the mean motions of *Mars* and *Juno* is such, that three times that of the former planet is very nearly equal to seven times of the latter, the difference amounting to about 12480'' in a year. There is, therefore, an inequality in the mutual action of those planets, having a period of about 104 years. It will be sensible principally in the mean longi-

$$\begin{aligned} \lambda l \textcircled{3} = & 2''.78 \sin (7 l' - 3 l - 3 \varpi' - \varpi) - 18''.35 \sin (7 l' - 3 l - 2 \varpi' - 2 \varpi) \\ & + 53''.31 \sin (7 l' - 3 l - \varpi - 3 \varpi') - 58''.38 \sin (7 l' - 3 l - 4 \varpi') \\ & - 1''.85 \sin (7 l' - 3 l - 2 \varpi - 2 \theta_0) + 4''.37 \sin (7 l' - 3 l - \varpi - \varpi' - 2 \theta_0) \\ & - 11''.74 \sin (7 l' - 3 l - 2 \varpi' - 2 \theta_0) - 1''.20 \sin (7 l' - 3 l - 4 \theta_0) \end{aligned}$$

θ_0 being the longitude of the ascending node of *Juno* on the orbit of *Mars*.

Observations of *Juno*, continued through a complete period of this inequality, will probably furnish a more accurate means of determining the mass of *Mars* than any other now known; since the largest periodic inequalities in the older planets pro-

tude of *Juno*. The following is the result of a rough computation of the terms depending on the fourth powers of the eccentricities and inclinations, and the above argument, — the mass of *Mars* being assumed equal to $\frac{1}{3680337}$, and the mean annual motion of *Juno* to 297090''.7.

duced by *Mars* amount to only two or three seconds, and the corresponding secular changes are so slow, that a period of a thousand years would be requisite to make them attain the same magnitude as the coefficients of the above periodic inequality.

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DETERMINATION OF THE MOON'S PLACE FROM OBSERVED OCCULTATIONS.

By LIEUT. J. M. SCHOFIELD,

West Point, N. Y.

THE great discrepancies in the places assigned to the moon by the British and American Ephemerides, and the conviction that the errors of even the latter are often quite considerable, have induced me to devote some attention to the use of occultations for the determination of the moon's place; and I would suggest the following method of computing the right-ascension and declination of the moon from two observed occultations of well-known stars.

Let t and t' be the times of occultation of two stars, the

interval $t' - t$ being not very great, or of immersion and emersion of the same star; α and δ , α' and δ' , their right-ascensions and declinations; $\Delta\alpha$ and $\Delta\delta$, $\Delta\alpha'$ and $\Delta\delta'$, the parallax in right-ascension and declination of the lunar points at which the occultations occur respectively; $m\alpha$ and $m\delta$ the moon's motions in right-ascension and declination in the time $t' - t$; and D the moon's declination at the time t , taken from the ephemeris; then will

$$\begin{aligned} (\alpha) &= \alpha \pm \Delta\alpha + m\alpha \frac{\cos D}{\cos(\delta \pm \Delta\delta)} & \text{and} & & (\delta) &= \delta \pm \Delta\delta \pm m\delta, \\ (\alpha') &= \alpha' \pm \Delta\alpha' & \text{and} & & (\delta') &= \delta' \pm \Delta\delta', \end{aligned}$$

give the places of two stars which would, to an observer at the center of the earth, be occulted at the same time t' ; and regarding as plane the triangles formed by the great circle through the places of these stars, their declination circles and

parallels of declination (the latter expressed in equinoctial units), and the moon's semidiameter, the right-ascension, A_m , and declination, D_m , of the moon, at the time t' , will result from the following simple formulas, viz.:—

$$\begin{aligned} \tan \varphi &= \frac{\alpha_1 \cos(\delta'_1)}{\delta_1}, & c &= \delta_1 \sec \varphi, & \cos \psi &= \frac{1}{2} \frac{c}{d}, \\ \delta_m &= d \cos(\psi \pm \varphi), & D_m &= (\delta) \pm \delta_m, \\ \alpha_m &= d \frac{\sin(\psi \pm \varphi)}{\cos D_m}, & A_m &= (\alpha) \pm \alpha_m, \end{aligned}$$

in which $\alpha_1 = (\alpha') - (\alpha)$, $\delta_1 = (\delta') - (\delta)$, and d = moon's semidiameter.

As an example, the emersions of 20 and η *Pleiadum*, on

the 14th of October, as observed at West Point, give at West Point 21^h 15^m 51^s.8 sidereal.

	Computed.	American Ephemeris.	Difference.	British Ephemeris.	Difference.
Moon's Right-ascension	^h 3 ^m 36 ^s 33.19	^s 33.13	^s —0.06	^s 33.92	^s +0.73
Moon's Declination	[°] 24 ['] 30 ["] 30.3	["] 28.7	["] —1.06	["] 33.7	["] +3.4

MOON-CULMINATING STARS.

OBSERVED APPARENT RIGHT-ASCENSIONS AND COMPARISON WITH EPHEMERIS.

By LIEUT. J. M. SCHOFIELD,

West Point, N. Y.

Star.	Date.	Observed α	Ephemeris.	Difference.	Star.	Date.	Observed α	Ephemeris.	Difference.
	1859.	h m s	s	s		1859.	h m s	s	s
<i>d Piscium</i>	Oct. 10	0 13 21.82	25.06	+0.24	η <i>Ophiuchi</i>	June 14	17 2 21.25	21.30	0.05
<i>d</i> "	11	0 13 24.79	25.07	0.28	η "	July 10	17 2 21.28	21.43	0.15
δ "	11	0 41 26.29	26.50	0.21	<i>A</i> "	June 14	17 6 44.72	44.90	0.18
ι <i>Leonis</i>	July 5	11 16 36.09	36.25	0.16	<i>A</i> "	July 10	17 6 44.78	45.06	0.28
ι "	6	11 16 36.16	36.24	0.08	<i>b</i> "	12	17 17 49.66	49.79	0.13
τ "	May 12	11 20 43.34	43.56	0.22	c^2 "	12	17 22 52.87	53.13	0.26
ν <i>Virginis</i>	July 4	11 38 38.45	38.72	0.27	o <i>Serpentis</i>	June 30	17 33 33.13	33.26	0.13
δ "	4	11 58 3.49	3.74	0.25	δ <i>Sagittarii</i>	14	17 51 15.04	14.92	0.88
δ "	5	11 58 3.50	3.73	+0.23	δ "	July 12	18 12 2.26	2.44	0.18
<i>Piazzi XII. 6</i>	May 12	12 4 29.91	29.63	-0.28	λ "	12	18 19 20.38	20.40	0.02
<i>g Virginis</i>	13	12 26 32.69	33.02	+0.33	ν^1 "	Oct. 2	18 45 42.94	42.99	0.05
ψ "	13	12 47 3.80	4.20	0.40	ζ "	July 12	18 53 42.79	43.08	0.29
δ "	July 5	12 48 32.33	32.49	0.16	ζ "	Oct. 3	18 53 41.97	42.40	0.43
δ "	6	12 48 32.38	32.18	0.10	τ "	July 12	18 58 12.45	12.65	0.20
<i>m</i> "	May 13	13 34 15.42	15.78	0.36	τ "	Oct. 3	18 58 11.87	12.02	0.15
86 "	June 11	13 38 28.30	28.56	0.26	χ^1 "	2	19 16 45.33	45.29	-0.01
94 "	11	13 58 52.78	52.89	0.11	χ^1 "	3	19 16 45.33	45.27	-0.06
χ "	July 8	14 5 25.36	25.58	0.22	c^2 "	3	19 33 30.63	30.87	0.24
χ "	9	14 5 25.31	25.57	0.23	<i>f</i> "	4	19 38 11.79	11.87	0.08
λ "	June 11	14 11 31.79	32.18	0.39	<i>b</i> "	4	19 48 21.50	21.57	0.07
μ "	11	14 35 40.86	41.09	0.23	<i>c</i> "	4	19 51 2.87	3.15	0.28
μ^2 "	July 8	14 35 41.70	40.93	0.23	<i>c</i> "	5	19 54 2.79	3.13	0.34
ξ^2 <i>Libræ</i>	June 11	14 49 10.32	10.49	0.17	π <i>Capricorni</i>	July 17	20 19 18.72	18.99	0.27
ξ^2 "	12	14 49 10.33	10.49	0.16	ν "	17	20 32 5.21	5.34	0.13
20 "	11	14 55 52.67	51.03	-1.64	ψ "	17	20 37 48.74	48.94	0.20
20 "	12	14 55 52.61	51.03	-1.58	ω "	Oct. 5	20 43 28.21	27.38	-0.83
ι "	11	15 4 14.58	14.75	0.17	ν <i>Aquarii</i>	July 17	21 1 58.41	58.47	0.06
ι^1 "	12	15 4 14.70	14.75	0.05	ν "	Oct. 5	21 1 58.35	58.55	0.20
ξ^1 "	27	15 20 21.77	21.86	0.09	ι <i>Capricorni</i>	July 17	21 14 27.26	27.63	0.37
ξ^1 "	July 9	15 20 21.72	21.81	0.09	ι "	Oct. 5	21 14 27.51	27.81	0.30
χ "	June 12	15 33 52.93	53.19	0.26	ε "	July 17	21 29 14.75	14.93	0.18
χ "	July 9	15 33 52.92	53.15	0.23	ε "	Oct. 6	21 29 15.16	15.19	0.03
λ "	June 27	15 45 12.59	12.80	0.21	γ "	May 21	21 32 18.68	18.96	0.28
λ "	30	15 45 12.54	12.79	0.25	γ "	Oct. 7	21 32 20.67	20.81	0.14
<i>q Scorpii</i>	July 10	15 48 14.57	14.99	0.42	δ "	May 21	21 39 17.14	17.55	0.11
δ "	June 27	15 52 3.57	3.68	0.11	δ "	Oct. 6	21 39 19.41	19.48	0.07
δ "	July 9	15 52 3.50	3.65	0.15	μ "	July 17	21 45 39.91	40.14	0.23
σ "	June 11	16 12 41.01	41.11	0.13	μ "	Oct. 6	21 45 40.39	40.52	0.13
σ "	27	16 12 40.99	41.18	0.19	ι <i>Aquarii</i>	July 17	21 58 52.72	52.92	0.20
τ "	14	16 27 10.24	10.60	0.36	ι "	Oct. 6	21 58 53.19	53.40	0.21
τ "	30	16 27 10.31	10.67	0.33	53 ² "	6	22 18 59.42	59.35	-0.07
20 <i>Ophiuchi</i>	14	16 42 5.65	5.65	0.00	σ "	6	22 23 15.07	14.22	-0.85
20 "	30	16 42 5.69	5.70	0.01	δ "	6	22 47 14.33	11.47	0.14
24 <i>Scorpii</i>	July 10	16 33 28.83	28.96	0.13	33 <i>Piscium</i>	10	23 58 11.45	11.51	0.06

MOON-CULMINATIONS.

OBSERVED APPARENT RIGHT-ASCENSIONS AND COMPARISON WITH EPHEMERIS.

By LIEUT. J. M. SCHOFIELD,

West Point, N. Y., assumed Longitude 4^h 55^m 50^s.10.

Date.	Limb.	Observed α	American Ephemeris.	Difference.	British Ephemeris.	Difference.
		h m s	s	s	s	s
1859, May 12	I	12 12 22.26	22.39	+0.13	23.07	+0.81
13	"	13 2 43.85	43.94	0.09	44.62	0.77
14	"	13 54 25.29	25.30	0.01	25.71	0.42
24	II	21 58 13.87	14.32	+0.45	14.44	+0.57

Date.	Limb.	Observed α	American Ephemeris.	Difference.	British Ephemeris.	Difference.
		^h ^m ^s	^s	^s	^s	^s
1859, June 9	I	12 46 50.67	50.80	+0.13	51.23	+0.56
11	"	14 29 43.66	43.84	0.18	44.32	0.66
12	"	15 24 8.12	8.41	0.29	8.85	0.73
14	"	17 17 44.90	45.33	0.43	45.67	0.77
July 8	"	14 13 25.40	25.58	0.18	25.96	0.56
9	"	15 7 2.09	2.51	0.42	2.79	0.70
10	"	16 2 28.11	28.41	0.30	28.57	0.46
11	"	16 59 8.03	8.22	0.19	8.28	0.25
12	"	17 55 53.20	53.59	0.39	53.65	0.45
17	II	22 10 19.77	19.83	0.06	20.20	0.43
Oct. 2	I	17 52 59.70	59.96	0.26	60.66	0.96
3	"	18 49 14.28	14.87	0.59	15.03	0.75
4	"	19 42 41.30	41.68	0.38	41.61	0.31
5	"	20 33 8.23	8.84	0.61	8.54	0.31
6	"	21 20 55.00	55.65	+0.65	55.28	0.28
10	"	0 21 14.61	14.23	-0.38	15.00	0.39
11	I	1 8 33.95 ⁽¹⁾	33.36	0.59	34.85	0.90
11	II	1 10 43.03 ⁽¹⁾	42.14	-0.89	44.05	+1.02

- ⁽¹⁾ 1 4.54 Observed time of semidiameter passing the meridian.
 1 4.39 American Ephemeris time of semidiameter passing the meridian.
 1 4.60 British Ephemeris time of semidiameter passing the meridian.

ALGOL-MINIMA.

OBSERVED AT WELD, FRANKLIN COUNTY, MAINE.

BY STILLMAN MASTERMAN.

Number of Period.	Observed Washington Mean Time of Minimum.				
			^h	^m	^s
+7597	1859, August	23	13	55	9
7598		26	10	38	32
7604	September	12	15	33	6
7606		18	8	59	22
7636	December	13	9	26	10
7637		16	6	14	37
7643	1860, Jan.	2	11	18	12
+7644		5	8	0	42

NOTE. — The observation of September 12 was taken when the condition of the atmosphere was somewhat unfavorable.

EPHEMERIS OF ALGOL-MINIMA, VISIBLE AT WASHINGTON, 1860.

1859, Dec. 7 15 55 ^{h m}	1860, Jan. 25 9 50 ^{h m}	1860, July 12 13 58 ^{h m}	1860, Oct. 6 14 13 ^{h m}	1860, Nov. 18 14 23 ^{h m}
10 12 44	28 6 39	Aug. 1 15 37	9 11 1	21 11 12
13 9 33	Feb. 14 11 34	4 12 26	12 7 50	24 8 1
16 6 22	17 8 23	24 14 5	26 15 53	Dec. 8 16 6
30 14 27	Mar. 8 10 8	27 10 53	29 12 42	11 12 55
1860, Jan. 2 11 16	11 6 57	Sept. 13 15 44	Nov. 1 9 30	14 9 44
5 8 5	31 8 41	16 12 33	4 6 19	17 6 33
22 13 0	June 19 15 29	19 9 21	15 17 34	31 14 38

Weld, Maine, 1860, Jan. 9.

S. MASTERMAN.

APPARENT RIGHT-ASCENSIONS OF THE MOON'S LIMB, AND OF MOON-CULMINATING STARS.

OBSERVED WITH THE TRANSIT-INSTRUMENT OF THE OBSERVATORY, WASHINGTON.

Date.	Object.	No. of Threads.	Apparent α		Date.	Object.	No. of Threads.	Apparent α	
			Observed.	Computed.				Observed.	Computed.
1859.					1859.				
Aug. 6	D I. Limb	25	^h 15 ^m 45 ^s 2.915	^s 3.01	Sept. 6	D I. Limb	25	^h 19 ^m 10 ^s 14.053	^s 14.51
6	δ Scorpii	15	52 3.338		6	α^3 Sagittarii	25	17 1.566	
6	β^1 Scorpii	25	57 17.806		6	h^2 Sagittarii	25	28 11.573	
6	σ Scorpii	25	16 12 40.854		7	h^2 Sagittarii	25	28 11.646	
6	α Scorpii	25	20 49.610		7	f Sagittarii	15	38 12.137	
6	τ Scorpii	15	27 10.213		7	c Sagittarii	15	54 3.110	
8	A^1 Ophiuchi	15	17 6 44.566		7	D I. Limb	25	20 2 18.750	19.14
8	θ Ophiuchi	25	13 24.977		7	σ Capricorni	25	11 19.438	
8	d Ophiuchi	25	18 25.192		7	q Capricorni	15	20 53.020	
8	c^2 Ophiuchi	15	22 52.715		8	σ Capricorni	25	11 19.485	
8	D I. Limb	25	38 27.997	28.37	8	q Capricorni	25	20 53.106	
8	λ Sagittarii	15	51 15.009		8	ν Capricorni	25	32 5.453	
8	γ Sagittarii	15	56 49.283		8	D I. Limb	25	51 39.785	40.01
8	μ Sagittarii	25	18 5 23.898		8	θ Capricorni	15	58 5.333	
10	q Sagittarii	25	36 55.067		8	ν Aquarii	15	21 1 58.832	
10	σ Sagittarii	25	46 35.535		8	i Capricorni	25	14 27.837	
10	τ Sagittarii	15	58 12.453		9	θ Capricorni	15	58 5 291	
10	α^1 Sagittarii	15	19 16 45.835		9	i Capricorni	25	14 27.818	
10	D I. Limb	25	28 7.479	7.74	9	γ Capricorni	15	32 20.846	
10	f Sagittarii	15	38 12.317		9	D I. Limb	25	38 37.681	37.92
16	i Piscium	25	23 32 45.666		9	μ Capricorni	25	45 40.638	
16	τ^1 Piscium	25	42 18.107		9	i Aquarii	25	58 53.406	
16	D II. Limb	25	0 8 53.401	53.37	9	θ Aquarii	25	22 9 27.663	
16	d Piscium	25	13 24.287		10	δ Capricorni	25	21 39 19.668	
16	λ^5 Piscium	25	18 29.507		10	i Aquarii	15	58 53.439	
17	d Piscium	25	13 24.164		10	θ Aquarii	25	22 9 27.603	
17	λ^5 Piscium	25	18 29.423		10	D I. Limb	25	23 51.791	52.00
17	δ Piscium	15	41 25.667		10	α Aquarii	15	30 31.320	
17	D II. Limb	25	51 33.414	33.42	10	λ Aquarii	25	45 19.592	
17	e Piscium	15	1 1 9.810		12	γ Piscium	25	23 9 55.464	
17	η Piscium	25	23 59.843		12	α Piscium	25	19 46.392	
17	π Piscium	15	29 40.888		12	ω Piscium	15	52 8.489	
18	η Piscium	25	23 59.921		12	D II. Limb	25	54 38.876	38.93
18	π Piscium	25	29 40.936		12	d Piscium	25	0 13 24.645	
18	D II. Limb	25	42 48.392	48.40	12	λ^5 Piscium	25	18 29.967	
18	β Arietis	15	46 54.733		12	ι^2 Ceti	25	22 54.626	
18	i Arietis	15	49 42.405		13	γ^5 Piscium	15	7 47.232	
18	α Arietis	25	59 17.117		13	d Piscium	25	13 24.672	
Sept. 2	D I. Limb	25	15 23 47.935	48.10	13	λ^5 Piscium	25	18 29.907	
2	δ Scorpii	15	52 2.924		13	D II. Limb	25	40 8.067	8.14
2	β^1 Scorpii	25	57 17.471		13	ϵ Piscium	25	55 41.709	
2	α Scorpii	25	16 20 49.127		18	ν^1 Tauri	25	4 17 56.268	
3	δ Scorpii	15	15 52 2.889		18	τ Tauri	25	33 50.787	
3	D I. Limb	25	16 21 13.021	13.09	18	i Aurigæ	25	47 52.899	
3	τ Scorpii	10	27 9.954		18	i Tauri	15	54 43.778	
6	q Sagittarii	25	18 36 54.665		18	D II. Limb *	25	5 14 53.466	52.83
6	σ^2 Sagittarii	15	41 21.803		18	β Tauri	15	17 26.502	
6	σ Sagittarii	25	46 35.339		18	ζ Tauri	25	29 16.500	
6	ζ Sagittarii	15	53 42.415						

The observations of September 2 were made by Professor MAJOR, the others by Professor YARNALL.

The computed place of the Moon is taken from the *American Ephemeris*.

1859, December 12.

M. F. MAURY.

* Moon's Limb very jagged.

MAXIMUM OF MIRA CETI.

LETTER FROM MR. MASTERMAN TO THE EDITOR.

Weld, Franklin Co., Maine, 1860, January 20.

I FIRST detected *Mira Ceti* with my naked eye on 1859, August 25; it being then a faint 6th magnitude star. From this it rose very rapidly at first, but finally more slowly, attaining its maximum brilliancy about the time indicated by Argelander's formula. It retained its greatest brilliancy for a number of days, and when a diminution became perceptible, it progressed for some time very slowly. Its decrease was at all times much slower than its increase, lasting nearly twice as long. Long-continued intervals of very unfavorable weather rendered the complete determination of its curve of brilliancy impossible. I have observed the star as much as possible, and

give you my resulting magnitudes in the table annexed. At its maximum brilliancy the star held a mean between stars of the 2d and 3d magnitude, being about two gradations brighter than β *Arietis*. The color of *Mira* at its maximum was about the same as that of α *Ceti*. To my eye, the maximum redness occurred a month after *Mira* reached its greatest brilliancy, and diminished considerably before the disappearance of the star. The star continued perceptibly red down to the 6th magnitude. Taking the mean of the period for which the brilliancy of the star was observed to be constant, I obtain 1859, October 10, for the date of maximum.

OBSERVED MAGNITUDES OF MIRA CETI.

Date, Washington Mean Time.	Observed Magnitude.	Date, Washington Mean Time.	Observed Magnitude.	Date, Washington Mean Time.	Observed Magnitude.	Date, Washington Mean Time.	Observed Magnitude.
1859, Aug. 31.64	5.3	1859, Oct. 4.54	2.5	1859, Nov. 3.40	2.7	1859, Dec. 13.36	4.9
Sept. 2.64	5.2	6.60	2.5	6.40	2.7	15.33	4.9
6.62	4.5	9.54	2.5	11.38	2.9	16.36	5.0
8.62	4.3	10.52	2.5	21.33	3.6	17.33	5.0
12.60	3.6	14.40	2.5	30.33	4.0	21.30	5.3
18.42	3.2	15.58	2.5	Dec. 8.33	4.6	27.30	5.7
28.53	2.7	26.60	2.7	10.36	4.7	29.30	5.7
29.60	2.7	29.57	2.7	12.36	4.8	1860, Jan. 12.26	6.0
Oct. 3.60	2.6	Nov. 2.40	2.7				

STILLMAN MASTERMAN.

ON A METHOD OF PROJECTING AN OCCULTATION.

By GEORGE SEARLE.

THE following application of BESSEL's theory to the projection of an occultation will, it is thought, usually furnish results sufficiently accurate for the purposes of the observer, in a shorter time, and with less danger of error, than the ordinary method of computation, founded on the same basis.

The data are the same as for that method, as given in the *American Ephemeris*; viz. δ , H , Y , p' , q' , $\log \sin D$, and $\log \cos D$; and they require only a brief reduction, as follows, to be applied to the projection. The values of $A \sin \varphi$ and $B \cos \varphi$ are to be got as usual for the place of observation; $A \sin \varphi \cos D - Y = a$, and $B \cos \varphi \sin D = b$, to be computed, and δ and H to be reduced to the place by subtracting its west longitude from Washington.

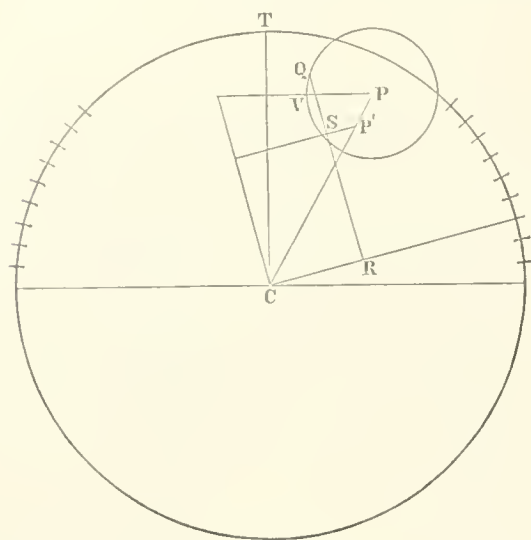
The first part of the projection is the same for all cases. Adopting any line for unity, a circle is to be drawn whose radius is unity, and one diameter with a radius CT , perpen-

dicular to it, and the circumference of the circle should be graduated into equal spaces ($5^\circ 0'.82$ would be convenient, being the amount of the earth's revolution in twenty minutes, mean time); the graduation extending from each end of the diameter about half-way to T . After this the work is different in each particular case.

In the first place, if D , the declination of the star, is positive, the perpendicular radius is to be directed upwards; if negative, it should point downwards. If D is zero, it makes no difference which method is used.

The projection is to be begun by laying off the reduced H on the circumference from T to the end of the diameter which is on the right. If H is negative, it is to be laid off toward the left. The center, C , is to be connected with this point on the circumference, and the point P to be placed on the radius thus drawn, at a distance from the center equal to $B \cos \varphi$.

The distance $PP' = b$ (which is always to be considered as positive) is to be laid off from P towards the center; and a circle must be drawn round P with radius equal to 0.273.



A curve is now to be constructed, the various points of which answer to various times; and the times at which it intersects the circle round P are the times of immersion and emersion.

To construct a point in this curve answering to the mean time $\phi + t$, (ϕ is here the reduced time of conjunction,) we must lay off on the radius which makes with the diameter an angle equal to the sidereal equivalent of t , the distance $CR = tp'$, t being here expressed in hours. The angle is to be laid off above if D is positive, below if D is negative; from the right-hand end if t is positive, from the left, if t is neg-

ative. At the point R we are to erect a perpendicular to CR , and drop on this perpendicular another (parallel with CR) from P' , and lay off from the foot of this new perpendicular, which may be called S , on RS , the distance $a - tq'$, upward being always the positive direction, t being also here expressed in hours. The point Q thus obtained is the desired point of the curve, and points being successively constructed, the curve may be drawn through them. The times of immersion and emersion may then be obtained by graduation on the curve.

If these points are constructed at equal intervals of time, and if the interval is twenty minutes, as contemplated in the graduation on the circumference, t becomes $n.20^m$; tp' , $tq' = n\frac{p'}{3}$, $n\frac{q'}{3}$, and the angles are furnished by the graduation.

In practice, we should seldom have to construct more than five points of the curve. It is obvious that, till the distance from P to RS becomes as small as 0.273, the immersion cannot take place, and the emersion must occur before it becomes greater.

The angles from north-point and vertex are obtained as follows. Considering the circle round P to represent the moon's disc as seen in the sky; and the point of intersection of the curve and circle, the position of the star at the instant of the phenomenon; the position of the north-point is got by drawing a diameter through P , parallel to RS at the time. The upper end of this diameter is the north-point. To get the vertex, draw a line through C , parallel to RS ; drop on it a perpendicular from P' , and lay off on the line, from the foot of the perpendicular, a distance $= A \sin \phi \cos D$, upward being always the positive direction. Connect P with the point thus determined; the connecting line intersects the circle at the vertex, V .

OBSERVATIONS OF POLYMNIA, LEDA, MNEMOSYNE, AND PANDORA.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — Observations of the Asteroids corrected for refraction.]

POLYMNIA.

Date.	M. T. Washington.	No of Comp.	Comparison-Star.	$\Delta \alpha$ ⁽³³⁾ — *	$\Delta \delta$ ⁽³³⁾ 's apparent	α	δ
1859, Nov. 26	9 ^h 6 ^m 52.7 ^s	9	Rümker, 2124 N.F.	+0 40.75	—8' 17.39	4 1 11.73	+23° 21' 37.33
Dec. 12	6 41 49.0	9	Rümker, 1039	—2 15.71	—6 54.15	3 46 32.14	+22 39 11.94

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
Rümker, N. F. 2124	9	4 ^h 0 ^m 29.17 ^s	+23° 29' 44.04"	Rümker's Catalogue.
Rümker, 1039	6	3 48 45.98	+22 45 54.72	

L E D A.

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽³⁸⁾ — *	$\Delta\delta$	α ⁽³⁸⁾ 's apparent	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	[°] ['] ["]
1859, Nov. 19	8 6 8.7	8	B. Z. 333, 48	—4 28.47	+8 1.28	2 25 26.64	+25 43 59.09
19	8 6 8.7	8	" 49	—5 4.75	+5 52.49	2 25 25.63	+25 43 59.31
20	8 9 23.4	9	* 21	—0 25.24	—3 57.40	2 24 36.24	+25 36 14.85

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
B. Z. 333, 48	9	2 29 52.56	+25 35 45.21	Bessel's Zones. Washington Equatorial.
" 49	9	2 30 28.85	+25 37 54.30	
* 21	9	2 24 59.94	+25 39 59.56	

M N E M O S Y N E.

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	Planet — *	$\Delta\delta$	Planet's apparent	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	[°] ['] ["]
1859, Dec. 15	7 58 46.3	3	Weisse, XXIII. 1235	—1 58.15	—18 32.37	23 58 33.02	+0 0 29.89
16	7 53 43.6	13	" 1235	—1 14.98	—17 45.75	23 59 15.89	0 1 16.60
20	8 1 7.3	13	" 1267	+0 36.25	+10 37.20	0 2 19.04	0 5 28.83
21	8 0 34.8	14	" 1267	+1 24.35	+11 59.95	0 3 7.12	0 6 51.17
23	7 59 21.9	12	" 1267	+3 3.36	+15 12.68	0 4 46.11	0 10 4.30
24	8 21 49.3	10	Weisse, O. 9	+3 19.94	—15 57.98	0 5 37.94	0 11 58.68
26	8 19 11.3	6	" 9	+5 4.03	—11 59.61	0 7 22.00	0 15 57.16
1860, Jan. 5	7 52 14.5	2	" 206	+4 3.06	—5 14.45	0 16 50.39	0 43 6.14
16	7 55 54.1	6	" 456	+1 25.38	—15 58.55	0 28 38.12	1 25 1.68
18	7 41 7.4	9	" 456	+3 40.84	—7 17.43	0 30 53.57	1 33 42.79
19	7 36 40.3	10	* 1	+0 47.44	—1 47.95	0 32 2.38	+1 38 15.60

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
Weisse, XXIII. 1235	8.5	0 0 30.14	+0 18 57.39	Bond's Harvard Catalogue. α Weisse's Catalogue, δ Yarnall.
1267	7	0 1 42.10	—0 5 12.92	
O. 9	7	0 2 17.36	+0 27 51.89	Bond's Harvard Catalogue.
O. 206	8	0 12 46.71	+0 48 16.89	
O. 456	9	0 27 12.22	+1 40 56.36	Weisse's Catalogue.
* 1	9	0 31 14.42	+1 39 59.66	Washington Equatorial.

P A N D O R A.

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽⁵⁵⁾ — *	$\Delta\delta$	α ⁽⁵⁵⁾ 's apparent	δ
	^h ^m ^s			^m ^s	['] ["]	^h ^m ^s	[°] ['] ["]
1860, Jan. 20	9 27 53.8	2	B. Z. 347, 39	—3 42.18	—4 52.54	9 4 17.26	+26 57 49.64
21	8 21 33.5	5	" 347, 39	—4 37.92	—1 34.61	9 3 21.53	27 1 7.65
21	8 40 22.1	9	" 347, 31	+1 7.11	—2 47.61	9 3 20.21	27 1 14.88
23	9 1 36.1	6	B. A. C. 3113	+0 45.36	—4 8.58	9 1 20.85	27 8 12.30
23	9 1 36.1	6	B. Z. 347, 31	—0 52.13	+9 43.65	9 1 21.00	27 8 13.60
25	9 11 27.2	20	B. A. C. 3113	—1 15.50	+2 21.67	8 59 20.02	+27 14 42.74

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
		^h ^m ^s	[°] ['] ["]	
B. Z. 347, 39	8	9 7 56.72	+27 2 47.97	Bessel's Zones.
347, 31	8	9 2 10.35	+26 58 35.69	
B. A. C. 3113	6.5	9 0 32.69	+27 12 26.44	Rümker's Catalogue.

NEW PLANET, INFERIOR TO MERCURY.

THE last European mails bring tidings of the probable discovery of a new planet between *Mercury* and the Sun. From communications of M. LEVERRIER to the Paris Academy of Sciences, January 2, the following facts are condensed.

M. LESCARBAULT, an amateur astronomer, residing at Orgères, had long since conceived the design of systematically examining the sun's disc, in the hope of thus perceiving and recognizing any possible small planet during its transit. In 1858 he began to put this plan in execution, having a telescope of 10 centimeters' aperture, and 1^m.46 focal length, simply mounted upon a wooden tripod. The eyepiece had a power of 150, and the telescope was provided with a finder magnifying 6 times. His measuring apparatus was constructed by himself, and consisted of three vertical and three horizontal threads in the finder, at intervals of 16' or 17'; a simple pair of cross-threads in the telescope; a pasteboard disc, movable around the finder as an axis, and divided into half-degrees. The threads being rectified by a plumb-line, and four cardinal points of the Sun's circumference given by setting two cross-threads of the finder tangent to the disc, the angular distance of any object upon the sun, from these points of tangency, is easily estimated.

Provided only with these simple contrivances, Mr. LESCARBAULT patiently carried on his search, until 1859, March 26, upon which day he had the gratification to discover what seems to have been a planet transiting the sun. It appeared as a small, black, circular object, well defined, its apparent diameter being about one quarter that of *Mercury* at the transit of 1815, which was witnessed by Mr. LESCARBAULT.

In the hope of again seeing and observing the object, this fact, and the attendant observations, were withheld from publication until December 22, when Mr. LESCARBAULT addressed a letter to Mr. LEVERRIER, communicating the observations as follows:—

1859, March 26,

Ingress upon the sun's disc 57° 22' 30" West from the upper extremity of the sun's vertical diameter,

3^h 59^m 46^s P. M. true time at Orgères,

4^h 8^m 11^s P. M. mean time at Paris,

the possible correction being from 1' to 5', additive.

Least distance from sun's center = 0° 15' 22".3,

4^h 38^m 20^s P. M. true time at Orgères,

4^h 46^m 45^s P. M. mean time at Paris.

Egress, 85° 45' West from the lower extremity of the sun's vertical diameter,

5^h 16^m 55^s P. M. true time at Orgères,

5^h 25^m 18^s P. M. mean time at Paris,

the possible correction being from 1' to 3', and subtractive.

Duration of the transit = 1^h 17^m 9^s M. T.

Length of the chord traversed = 9' 13".6.

Corresponding sidereal time requisite for passing through a distance equal to the sun's diameter = 4^h 29^m 9^s.

From these data Mr. LESCARBAULT concluded that the planet must move in an orbit inclined to the ecliptic by an angle between 5½° and 7½°; that its ascending node is not far from 183°; and, unless the eccentricity should be extremely great, that its mean motion would correspond with an apparent motion through a distance equal to the sun's diameter in about 4½ hours.

Upon the reception of this most interesting communication, Mr. LEVERRIER visited the author at his residence, a little village about 60 miles southwest from the French capital, and situated, according to the government charts, in

Lat. 48° 8' 55" N. Long. 0^h 2^m 35^s West from Paris.

He examined in detail the apparatus used, and obtained from Mr. LESCARBAULT a minute account of all the circumstances of the observations. He found that the ingress itself had not been observed, but that the body had entered upon the solar disc some seconds before it was perceived, and the moment of ingress was obtained by estimation; and that the deductions of Mr. LESCARBAULT had been obtained by the employment of graphic methods. Mr. LEVERRIER reports that the manifest simplicity of character, and the thorough explanations given by the discoverer, had led him to the full conviction that the observation may claim entire credence, and that the long delay in making it known is referable solely to the modesty and reserve of the author.

Submitting the observations to careful discussion, Mr. LEVERRIER obtains the following results.

Chord traversed = 9' 17"

Corresponding time for traversing the sun's diameter = 4^h 26^m 48^s.

Upon the assumption of a circular orbit,

Semi-axis major = 0.1427

Time of revolution = 19^d.7

Inclination of the orbit = 12° 10'

Longitude of ascending node = 12° 59'

Greatest elongation = 8°.

If, as estimated, the apparent diameter of the new planet was no more than one quarter that of *Mercury* at the transit of 1815, its mass could not exceed 1/17 part that of the latter planet.

1860, Feb. 4.

G.

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NEW PLANET, INFERIOR TO MERCURY.

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NO. 12.

ELEMENTS AND EPHEMERIS OF LEUCOTHEA FOR 1860.

By E. SCHUBERT.

THIS planet could not be found in the second and fourth periods of apparition, on account of its faintness, and since the elements of the orbit were not near the truth. It is therefore very desirable that it be observed again during the next period, in 1860, and there is hope that it may be, on account both of the greater intensity of its light then, and of the following results of calculation.

For the basis of these calculations the approximation of elements by G. RÜNKER was adopted, viz.: —

1855, May 11.0, Berlin M. T.

$$\begin{aligned} M &= 1^{\circ} 38' 35.9'' \\ \pi &= 198 \ 17 \ 1.7 \\ \Omega &= 356 \ 24 \ 39.6 \\ i &= 8 \ 15 \ 17.7 \\ \varphi &= 13 \ 12 \ 4.2 \\ \mu &= 692''.7935 \end{aligned} \left. \vphantom{\begin{aligned} M \\ \pi \\ \Omega \\ i \\ \varphi \\ \mu \end{aligned}} \right\} \text{M. eq. ep.}$$

For the first period Mr. RÜNKER has computed (*Astr. Nach.*, No. 1011): —

Normal place, 1855, April 24.0, Berlin M. T. $\alpha = 180^{\circ} 37' 8''.0$; $\delta = -5^{\circ} 10' 4''.3$.

I have compared the observations of the third period, and from five observations at Berlin have derived a second normal place, as follows: —

	$\Delta\alpha$	$\Delta\delta$	
1857, Oct. 19.45145 Berlin M. T.	$-1^m 13.39^s$	$-9' 43.6''$	Cambridge (England).
24.43572 “	1 16.82	9 44.0	“ “
Nov. 11.30036 “	1 13.10	9 11.3	Berlin.
15.46729 “	1 12.67	8 57.8	“
16.35747 “	1 12.66	8 53.6	“
18.46629 “	1 13.75	8 51.4	“
19.45072 “	$-1 \ 13.35$	$-8 \ 46.6$	“
Mean,	$-1 \ 13.11$	$-8 \ 58.1$	
Computation, November 16.0	$0^h 13 \ 18.00$	$+5^{\circ} 26 \ 18.0$	
Normal place referred to true equinox, {	$0^h 14 \ 31.11$		
	$3^{\circ} 37' 46''.5$	$+5^{\circ} 35 \ 16.1$	

With the above elements the perturbations by *Jupiter* have been computed, and give the following osculating elements: —

1855, April 24.0, Berlin M. T.

$$\begin{aligned} M &= 358 \ 22' 18.1'' \\ \pi &= 198 \ 17 \ 0.1 \\ \Omega &= 356 \ 24 \ 36.6 \\ i &= 8 \ 15 \ 17.6 \\ \varphi &= 13 \ 12 \ 7.8 \\ \mu &= 692''.7709 \end{aligned} \left. \vphantom{\begin{aligned} M \\ \pi \\ \Omega \\ i \\ \varphi \\ \mu \end{aligned}} \right\} \text{M. eq. ep.}$$

1857, November 16.0, Berlin M. T.

$$\begin{aligned} M &= 178^{\circ} 14' 14.0'' \\ \pi &= 198 \ 41 \ 41.8 \\ \Omega &= 356 \ 46 \ 26.1 \\ i &= 8 \ 14 \ 8.2 \\ \varphi &= 13 \ 3 \ 2.5 \\ \mu &= 690''.4864 \end{aligned} \left. \vphantom{\begin{aligned} M \\ \pi \\ \Omega \\ i \\ \varphi \\ \mu \end{aligned}} \right\} \text{M. eq. ep.}$$

By the computation of the normals from these elements was obtained, —

$\Delta \alpha \cos \delta$	$\Delta \delta$
—1614".7	+625".8
+ 286".0	+186".4

from which I have determined corrections for M , φ , π , and μ , leaving i and Ω unchanged. The equations of condition are :—

+2.3111 $d M$	—0.6178 $d \varphi$	+1.4192 $d \pi$	—112.896 $d \mu$	—1644.7	= 0
+0.6740	+0.2269	+1.0381	+572.660	+ 286.0	= 0
—1.4880	+0.2328	—0.9112	+ 46.707	+ 625.8	= 0
+0.4221	+0.0932	+0.6505	+370.940	+ 186.4	= 0

and they are satisfied by

$$d M = -1^{\circ} 5' 10''.8 \quad d \varphi = -25' 11''.0 \quad d \pi = +1^{\circ} 45' 38''.9 \quad d \mu = -6''.7892$$

If we now add these corrections to the above osculating elements, we have, by computing anew the normal places,

$\Delta \alpha \cos \delta$	$\Delta \delta$
+106".26	—72".00
—103".60	—63".00

as the effect of the second differential coefficients, the resultant corrections being very considerable. Equations were therefore formed with coefficients once more corrected. These are, —

+2.17565 $d M$	—0.67754 $d \varphi$	+1.35920 $d \pi$	—108.435 $d \mu$	+106.2	= 0
+0.68420	+0.29015	+1.03731	+581.530	—103.6	= 0
—1.39350	+0.27688	—0.86746	+ 44.271	— 72.2	= 0
+0.42841	+0.13266	+0.65025	+376.480	— 63.0	= 0

from which,

$$d M = -4' 48''.8 \quad d \varphi = +5''.3 \quad d \pi = +6' 14''.6 \quad d \mu = -0''.1528$$

The sum of all the corrections applied to the original elements gives finally, —

1855, May 11.0, Berlin M. T.

$$\begin{array}{l} M = 0^{\circ} 28' 36''.3 \\ \pi = 200^{\circ} 8' 55''.2 \\ \Omega = 356^{\circ} 24' 39''.6 \\ i = 8^{\circ} 15' 17''.7 \\ \varphi = 12^{\circ} 46' 58''.5 \\ \mu = 685''.8515 \end{array} \left. \vphantom{\begin{array}{l} M \\ \pi \\ \Omega \\ i \\ \varphi \\ \mu \end{array}} \right\} \text{M. eq. ep.}$$

As a check for the whole, the computation of the Cambridge observation of October 19 gave $\Delta \alpha = +22''.4$ and $\Delta \delta = +2''.0$. The greatness of $\Delta \alpha$ makes it probable that the observed right-ascension is too small, for the above comparison of the two Cambridge observations shows a discordance of $\Delta \alpha$.

With these now more approximated elements, I have computed anew the perturbations by *Jupiter*.

For the apparition in 1858 I had computed an ephemeris with the original elements, and, as an example, found for November 28.5, —

Apparent α	Apparent δ
Berlin M. T. $63^{\circ} 55' 17''.4$	+32^{\circ} 29' 38''.7

The corrected elements give, —

$63^{\circ} 16' 9''.0$	$32^{\circ} 18' 40''.0$
------------------------	-------------------------

PERTURBATIONS BY JUPITER FROM 1855, MAY 11.0, TO 1860, MARCH 5.0.

$d i = -3' 7''.0$	$d \mu = -3''.5000$
$d \Omega = -33' 34''.0$	$d M = -53' 7''.8$
$d \varphi = -26' 32''.7$	$f d \mu = -62' 39''.5$
$d \pi = +36' 9''.0$	

OSCULATING ELEMENTS.

1860, March 5.0, Berlin M. T.

$$\begin{array}{l} M = 333^{\circ} 51' 7''.6 \\ \pi = 200^{\circ} 49' 6''.3 \\ \Omega = 355^{\circ} 55' 7''.7 \\ i = 8^{\circ} 12' 10''.7 \\ \varphi = 12^{\circ} 20' 25''.8 \\ \mu = 682''.3515 \end{array} \left. \vphantom{\begin{array}{l} M \\ \pi \\ \Omega \\ i \\ \varphi \\ \mu \end{array}} \right\} \text{M. eq. ep.}$$

EPHEMERIS FOR THE OPPOSITION IN 1860.

Washington Mean Midnight.		Apparent α	Apparent δ	Log r	Log d	Washington Mean Midnight.		Apparent α	Apparent δ	Log r	Log d
Feb.	10	^h 11 ^m 3 ^s 47.00	+11° 15' 43.3"	0.39737	0.19083	March	10	^h 10 ^m 38 ^s 36.76	+12° 2' 4.7"		
	11	3 4.56	17 24.3				11	37 44.30	2 47.3	0.38967	0.17049
	12	2 21.14	19 8.0	.39683	.18738		12	36 52.55	3 23.5		
	13	1 36.40	20 54.2				13	36 1.53	3 53.2	.38920	.17162
	14	0 50.53	22 42.6	.39629	.18420		14	35 11.31	4 16.5		
	15	11 0 3.51	24 32.7				15	34 21.99	4 33.0	.38873	.17304
	16	10 59 15.44	26 24.2	.39575	.18131		16	33 33.63	4 42.3		
	17	58 26.41	28 16.8				17	32 46.29	4 44.2	.38826	.17475
	18	57 36.51	30 9.8	.39522	.17870		18	32 0.11	4 38.1		
	19	56 45.80	32 2.8				19	31 15.09	4 24.4	.38780	.17675
	20	55 54.20	33 56.2	.39469	.17637		20	30 31.26	4 3.1		
	21	55 1.83	35 49.5				21	29 48.66	3 33.9	.38735	.17900
	22	54 8.78	37 42.1	.39416	.17436		22	29 7.36	2 56.9		
	23	53 15.13	39 33.7				23	28 27.39	2 11.9	.38692	.18151
	24	52 20.98	41 23.9	.39365	.17265		24	27 48.81	1 18.9		
	25	51 26.39	43 12.2				25	27 11.63	12 0 17.8	.38648	.18425
	26	50 31.41	44 58.0	.39314	.17126		26	26 35.94	11 59 8.2		
	27	49 36.13	46 41.3				27	26 1.75	57 50.4	.38604	.18723
	28	48 40.66	48 21.6	.39263	.17020		28	25 29.08	56 24.4		
	29	47 45.07	49 58.2				29	24 57.97	54 50.1	.38561	.19041
March	1	46 49.42	51 31.1	.39212	.16945		30	24 28.48	53 7.4		
	2	45 53.81	52 59.8				31	24 0.59	51 16.7	.38519	.19378
	3	44 58.28	54 24.5	.39162	.16903	Apri	1	23 34.33	49 17.5		
	4	44 2.88	55 44.9				2	23 9.71	47 12.2	.38477	.19734
§	5	43 7.64	57 0.7	.39112	.16891		3	22 46.74	44 54.8		
	6	42 12.60	58 11.9				4	22 25.44	42 41.1	.38436	.20107
	7	41 17.89	11 59 18.3	.39064	.16913		5	22 5.94	39 59.4		
	8	40 23.61	12 0 20.1				6	10 21 48.10	+11 37 20.1	0.38395	0.20494
	9	10 39 29.86	+12 1 15.9	0.39015	0.16966						

§ 1860, about March 5. Intensity of light = 2.7.

ON THE ROTATION OF THE PLANETS UPON THEIR AXES.

I TAKE the liberty of calling the attention of astronomers to a rather neglected, though highly interesting and important subject, viz. the rotation of the planets upon their axes. Speculations and investigations have been instituted hitherto only upon a part of the planetary motion, namely, on the motion of the center of the planet in its orbit round the sun. But the motion of the planets is rotatory-progressive, and it is the duty of astronomers to find out the forces and laws which create and govern that motion; for so long as that is not done, further progress is impossible. It is more than probable that the rotation is not accidental to the revolution; the time has never been when a planet merely revolved round the sun, and did not rotate at the same time.

Before I proceed to show some curious numbers, I beg leave to offer for the consideration of scientists some general remarks on laws of nature.

In every natural phenomenon there is a complication of different laws; one of them may be the leading thought, the fundamental law; the others may present themselves as regular perturbations of the fundamental law. For instance, the

ellipse (or, generally speaking, a conic section) is the fundamental character of the motion of the planets round the sun; but in consequence of the planetary perturbations, that motion is not exactly elliptical. The first step taken by KEPLER was to show that the planets move in ellipses, and that this is the fundamental law for the motion of the planets round the sun. Afterwards, when NEWTON had found the law of gravitation, it became possible to determine how much that fundamental character was affected by the perturbations.

I have ever been inclined to believe that the well-known series of TITUS is a law of nature, although there is some deviation for *Mercury* and *Neptune*. For convenience, I will repeat here the perfect series:—

$$\begin{array}{rcl}
 4 + 3 \times 2^{-1} & = & 5\frac{1}{2} \\
 4 + 3 \times 2^0 & = & 7 \quad 1\frac{1}{2} \\
 4 + 3 \times 2^1 & = & 10 \quad 3 \\
 4 + 3 \times 2^2 & = & 16 \quad 6 \\
 4 + 3 \times 2^3 & = & 28 \quad 12 \\
 & & \&c. \quad \&c.
 \end{array}$$

I believe this is the fundamental law for the distances of the

planets from the sun, and it is the business of astronomers to find out what is the cause of the considerable perturbations in the named cases. Mr. LEVERRIER recently found that the secular variation of the perihelion of *Mercury* cannot be explained by the mass of *Venus*, and thinks it probable that there are other small planets in the vicinity of *Mercury*. There may be a group of small planets in that region, analogous to that of the asteroids, and perhaps the mean distance may be represented by the term $4 + 3 \times 2^{-1}$. If we take the arithmetical mean of all the mean distances of the known asteroids from the sun, we find that it comes very near the term $4 + 3 \times 2^3$.⁽¹⁾ *Neptune* may also belong to such a

ring. The ring of the asteroids and the other probable rings round the sun are analogous to the rings of *Saturn*.

For a great many years I had tried in vain to discover something like a law for the rotation of the planets. About three years ago I took up numbers which I had computed several years before, viz. the distances of the so-called centers of free rotation from the center of the planets. They are obtained by means of the formula $e = \frac{t}{T} \cdot \Delta$, where t denotes the sidereal time of rotation, T the sidereal time of revolution, and Δ the distance of the planet from the sun.

<i>Earth</i> ;	$\Delta = 1.00 = 20682440$ geographical miles;	$\frac{t}{T} = \frac{23.93}{8766}$;	$\frac{t}{T} \cdot \Delta = e = 56460$ geographical miles. ⁽²⁾
<i>Venus</i> ;	$0.72 = 14953000$	$\frac{23.36}{5396}$	$e = 64770$
<i>Mars</i> ;	$1.52 = 31520000$	$\frac{24.6}{16493}$	47013
<i>Jupiter</i> ;	$5.20 = 107610000$	$\frac{9.93}{103961}$	10279
<i>Saturn</i> ;	$9.54 = 197290000$	$\frac{10.5}{258220}$	8022

If we now take the quotients $\frac{e}{\Delta}$, we have, for

<i>Venus</i>	0.87	$\Delta = 0.72$
<i>Mars</i>	1.20	1.52
<i>Jupiter</i>	5.49	5.20
<i>Saturn</i>	7.04?	9.54

The resemblance of these quotients to the distances from the sun are remarkable. Before that, I had always been distrustful of those 10.5 hours for the rotation of *Saturn* as the single estimation of SCHROETER, and because I was averse to the belief that, at a distance twice that of *Jupiter*, the rotation of *Saturn* could be slower than that of *Jupiter*. If we introduce 8 hours instead of 10.5, we obtain very nearly the distance from the sun. Two years ago a friend of mine saw a very prominent and marked spot on *Saturn* for several weeks every evening at the same hour in the same situation. Now this would speak for 8 hours ($3 \times 8 = 24$), since 12 hours are less probable, and it is very desirable that astronomers should try to discover a spot, and to determine the time of the rotation of *Saturn* more exactly.

Let us suppose that there has been a time when the whole mass of the solar system was not divided yet, but was rotating upon an axis. In a certain state of aggregation the planets were thrown off, or became individuals. The centrifugal force by which they were thrown off, in combination with the gravitation towards the sun, forced them to describe orbits round the sun. But the planets were not solid then; they consisted of discrete particles; these particles of a planet were also compelled

to describe orbits round their special common center of gravity, and that circumstance, perhaps, in connection with a polar force, as made probable in case of the comets, may be the cause of the rotation. The revolution of the moon round the earth, for instance, is nothing else but the modified participation in the rotation of the earth. Every particle of a planet is obedient to two masters,—to the common center of gravity in the planet itself and to the sun.

Now from the above numbers follows:—

$$e : e' = \frac{1}{\Delta} : \frac{1}{\Delta'}, \text{ or } \Delta e = \Delta' e';$$

or, if for e and e' we substitute $\frac{t}{T} \Delta$ and $\frac{t'}{T'} \Delta'$, we have

$$\frac{t}{T} \Delta^2 = \frac{t'}{T'} \Delta'^2;$$

i. e. the quotients of the times (the time of rotation divided by the time of revolution) are in the inverse ratio of the squares of the distances from the sun,—they follow the simple law of gravitation. This is probably the fundamental law for the rotatory-progressive motion of the planets, but it is disturbed by the difference in the masses and the densities. If the mass of *Mars* were equal to that of the earth (it is in reality much less), the time of rotation would be shorter, e would be smaller, and $\frac{e}{\Delta}$ greater; and if the mass of *Jupiter* were equal to that of the earth, the time of *Jupiter's* rotation would be longer, and $\frac{e}{\Delta}$ smaller. In both cases the variation would be in the right direction.

⁽¹⁾ It is from the first 55 asteroids $= 2.7$; the series gives 2.8, which makes it probable that there are more asteroids in the region of the exterior limit of the ring, but undiscovered as yet.

⁽²⁾ German geographical miles, of which 15 are equal to one degree of the meridian.

For the revolution alone we have KEPLER's law, —

$$T^2 : T'^2 = d^3 : d'^3 ;$$

and for the rotation alone we obtain

$$\begin{aligned} \frac{t}{T} d &= e & \frac{t'}{T'} d' &= e' , \\ &= e' \frac{d'}{d} \\ &= e' \left(\frac{T'}{T} \right)^{\frac{3}{2}} \\ &= \frac{t'}{T'} d' \left(\frac{T'}{T} \right)^{\frac{3}{2}} \\ \frac{t}{T} \cdot \frac{d}{d'} &= \frac{t'}{T'} \left(\frac{T'}{T} \right)^{\frac{3}{2}} \end{aligned}$$

$$\frac{t}{T} \left(\frac{T'}{T} \right)^{\frac{3}{2}} = \frac{t'}{T'} \left(\frac{T'}{T} \right)^{\frac{3}{2}}$$

$$\frac{t}{t'} = \frac{T}{T'} \cdot \frac{T'^{\frac{3}{2}}}{T^{\frac{3}{2}}} = \sqrt[3]{\frac{T}{T'}}$$

and

$$t : t' = d^{\frac{1}{2}} : d'^{\frac{1}{2}}$$

One sees at once that, in general, with the greater distance from the sun, the time of rotation is shorter, and the number of satellites increases. *Saturn* is smaller than *Jupiter* or *Uranus*, and *Neptune* smaller than *Saturn*. If, now, *Jupiter* as it is could be removed to the distance of *Neptune*, where the time of rotation from the above law would be about $4\frac{1}{2}$ hours, it would be impossible that *Jupiter* could keep its magnitude; part of its mass would be thrown off, and satellites would be formed of it. Who would not think here of LA PLACE's celebrated hypothesis?

Some twenty years ago, when living in a village in Silesia, I was studying mathematics and astronomy by myself. When I came, in LITTROW's *Wunder des Himmels*, to where the rotation of the planets is explained by the assumption that the direction of a primitive impulse (necessary for the explanation of the revolutions) did not go through the center of the planets, but at some distance from that center, I felt rather uneasy, — I could not bear the idea that God should have created the systems of the universe in such a mechanical manner. *The universe is not a mechanism, but an organism*. At that time I was not prejudiced at all, for it was before my going to the University and Observatory of Breslau. I commenced speculating on the rotation of the planets, and tried, in the first place, to get a clear idea of that rotation. The result was, the same theory published by Mr. POINSON in the *Connaissance des Temps*, for 1854. Mine was published in 1847, in Dr. NÜRNBERGER's *Astronomisches Wörterbuch*. I had discussed the simplest case, namely, when the plane of rotation is the same with the plane of revolution; or, as POINSON has it, when the two cones are two cylinders. My reasoning was as follows.

If we strike a ball free in space, not acted upon by any other disturbing force, so that the direction of the stroke goes through the center of the ball, the ball will move on in the direction of the stroke without any rotation. Now, if we put the ball on a horizontal table, and strike it again centrally, as before, the motion will be rotatory-progressive. We must here of necessity seek the cause for the rotation in the pressure of the ball on the table. After the stroke, there is a tendency of the ball to turn round an axis passing through the point of contact, and in the plane of the table, and not to rotate upon an axis passing through the center of the ball. But the ball is prevented by the table from turning round that axis going through the point of contact; a point of the surface of the ball, however, infinitely near the first point of contact,

comes in contact with the next point on the table, and since there is still the effect of the stroke, the ball tends to turn round an axis passing through this second point of contact, etc., and it is in this way that the rotatory-progressive motion of the ball is produced.

In the case of such a ball rolling on a table, the point of rotation is on the surface of the ball, and it is the center of the so-called free rotation, for the space gone through by the center of the ball in a certain time is exactly equal to the space gone through in consequence of the rotation alone, by a certain point of that great circle whose points come successively in contact with the table. Therefore, when a whole rotation is perfected, the space through which the center moved in the same time is equal to the circumference of a great circle of the ball.

For the determination of the position of a given point after a certain time, the mere mathematician is allowed to assume that the ball is moving in a certain orbit with a certain velocity, and rotating at the same time with a certain velocity upon an axis passing through its center, for it is his business only to determine a *quantum*; but in order to explain a phenomenon, we have to find out its true essence, we have to study its physical properties, — to determine a *quale*.

When I had analyzed in that manner the rotatory-progressive motion of such a ball, I applied the same principle to the motions of the planets, assumed the plane of rotation identical with the plane of revolution as the simplest case, increased the radius of a planet to equality with the distance of the center of free rotation from the center of the planet, and let then the planet roll, without gliding, upon a curve round the sun. That is exactly the same theory of rotation which Mr. POINSON came to.

Last summer I was sitting in the open air, in the town of Goslar, in the Harz Mountains of Germany, with a cup of

coffee before me. After having put in the sugar, and having made some gyrations with the teaspoon, I observed the following highly interesting phenomenon. A great many air-bubbles rose to the surface, all moving round the center of the cup; those nearest to the center crowded at once together, arranged themselves in a circular central body, and rotated, as we would call now the motion of all the different parts united, round the center. Others more remote from this center were describing orbits round it. Two of them approached each other; I followed their motions with great attention, perceiving distinctly that they were attracting each other, when they suddenly united, and moved round their common center of gravity, and of course in the same direction in which this common center was describing an orbit round the center of the cup. Now, if there were more than two such bubbles united in that manner they would have formed a planet rotating upon an axis and

revolving round the central body. All that was LA PLACE's famous hypothesis in miniature.

I should therefore define the rotation of the planets upon their axes as the combination of the motions of all the particles of which a planet consists round their common center of gravity in the planet itself. Now it is easy to account for the invariability of the sidereal days; they are essentially times of revolutions, and as such they must be constant. Let us suppose it had been possible that those above two bubbles had not moved in the same plane going through the center of revolution, they would have attracted each other also, and commenced moving round their common center of gravity; but the plane of this motion would not have coincided with the plane of revolution of the common center of gravity round the central body. The so-called obliquities are essentially inclinations.

E. SCHUBERT.

LONGITUDE OF SANTIAGO DE CHILE.

By J. M. GILLISS.

ON revising the computations for the longitude of the Observatory on Santa Lucia, 88 culminations of the moon's first limb, 16 culminations of the second limb, and 15 occultations of stars have been availed of, which were not embraced in the results published on pages *l.* and *li.* of the Introduction to Vol. III. of the *U. S. Naval Astronomical Expedition to the Southern Hemisphere.*

In that volume the longitude from moon-culminations is deduced from corresponding observations on the meridians of the several Observatories. The additions in the revision are almost entirely derived from meridian observations at Santiago compared with tabular places of the moon, corrected in accordance with errors on the same dates drawn by observations with the Greenwich alt-azimuth instrument. The additional occultations are of small stars, and though many of them give accordant results, as their places cannot be considered to have been determined accurately, such results must be regarded as accidental.

Giving to the moon-culminations weights computed by GAUSS's formula, and to the result from each occultation which bears the test of Professor PEARCE's criterion the weight unity, we have as follows:—

	Corrections to Longitude.	Weights.
250 culminations, Moon's first limb,	+14.445	79.102
65 " Moon's second limb,	13.964	22.823
39 occultations,	14.147	24.000

and the correction adopted = +14°.301, or

Longitude 4^h 42^m 33°.3 W.

In this connection it may be proper to observe, that the observations of the moon at Santiago are not corrected for azimuthal deviation of the transit-instrument, and therefore, when its apparent observed right-ascensions shall have been calculated, a farther small correction to the above value may become necessary.

Nor may it be without interest to state, that a star of the 7.8 magnitude, whose occultation was observed at 7^h 40^m 48°.3 (mean time Santiago), 1852, February 29, cannot now be recognized. Observations on the planet *Mars* and a star of (BESSEL's) 9 magnitude were commenced fifteen minutes later, and were interrupted by thin cirri within half an hour. The note for the night to the latter work is, "Star extremely faint." Mr. FERGUSON has very recently examined the portion of the heavens in which the moon was at the instant of the occultation, and found only stars of the 10 magnitude. *Mars* and the moon differed in right-ascension by 1^h 43^m, and in declination 2°; and had it been possible to see a star so small as 10th, it certainly could not have been mistaken for one of 7.8 magnitude. Moreover, as the night airs of summer at Santiago came from the Andes (east), and clouds, if any, accumulated apparently against the wind, it is probable that the occultated star was partially obscured by the cirri, and its magnitude underrated.

OBSERVATIONS OF PANDORA, EGERIA, AND LEUCOTHEA.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — Corrected for refraction.]

P A N D O R A .

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽⁵⁵⁾ — *	$\Delta\delta$	α ⁽⁵⁵⁾ 's apparent	δ
1860, Feb. 10	^h 8 ^m 52 ^s 16.5	3	B. Z. 349, 20	^m —0 ^s 54.97	['] +17 ["] 12.96	^h 8 ^m 43 ^s 20.54	[°] +27 ['] 49 ["] 19.83
23	7 42 55.9	3	" 349, 10	—3 1.14	+ 8 15.46	8 32 32.59	+27 51 42.65
25	8 5 16.9	4	" 352, 19	—1 30.67	+14 12.86	8 31 9.90	+27 49 57.45

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
B. Z. 349, 20	9	^h 8 ^m 44 ^s 12.52	[°] +27 ['] 32 ["] 11.78	} Bessel's Zones.
" 10	8	8 35 30.73	+27 43 30.36	
" 352, 19 and 349, 8 }	8	8 32 37.61	+27 35 48.62	

E G E R I A .

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽¹³⁾ — *	$\Delta\delta$	α ⁽¹³⁾ 's apparent	δ
1860, Feb. 4	^h 8 ^m 42 ^s 33.6	16	B. Z. 494, 82	^m +1 ^s 25.39	['] + 8 ["] 25.96	^h 9 ^m 24 ^s 42.51	[°] +44 ['] 29 ["] 46.32
Mar. 1	7 49 36.2	8	" 37	+1 34.75	+18 53.22	8 57 9.88	+43 55 12.95

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
B. Z. 494, 82	7	^h 9 ^m 23 ^s 13.51	[°] +44 ['] 21 ["] 27.95	} Washington Mural, Yarnall, and Bessel's Zones.
" 37	8	8 55 31.52	+43 36 21.11	

L E U C O T H E A .

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽³⁵⁾ — *	$\Delta\delta$	α ⁽³⁵⁾ 's apparent	δ
1860, Mar. 15	^h 9 ^m 13 ^s 42.4	2	Weisse, X. 468	^m +2 ^s 41.03	['] —12 ["] 2.65	^h 10 ^m 29 ^s 40.82	[°] +12 ['] 41 ["] 51.03
20	8 30 8.2	13	" " 468	—1 5.26	—13 1.78	10 25 54.51	12 40 52.04
21	8 24 56.9	6	" " 468	—1 45.63	—13 40.39	10 25 14.14	12 40 13.46
22	8 38 38.8	17	" " 378	+2 31.19	—14 26.71	10 24 33.93	+12 39 31.65

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
Weisse, X. 468	9	^h 10 ^m 26 ^s 56.97	[°] +12 ['] 54 ["] 6.45	} Weisse's Catalogue.
" " 378	8	10 21 59.95	+12 54 10.62	

ALGOL-MINIMA.

OBSERVED AT WELD, FRANKLIN COUNTY, MAINE.

By STILLMAN MASTERMAN.

Number of Period.	Observed Washington Mean Time of Minimum.				
+7658	1860, February	14	11 ^h	34 ^m	36 ^s
7659		17	8	24	31
+7667	March	11	6	56	26

NEW WORK.

Places of 5345 Stars, observed from 1828 to 1854, at the Armagh Observatory. By Rev. T. R. ROBINSON, D.D. Dublin, 1859. pp. 847. — This large octavo work, printed upon the recommendation of the Royal Society at the expense of the British government, now so liberal in the maintenance and furtherance of scientific investigation, cannot fail to be welcomed with gratitude by astronomers. It contains the fruits of more than a quarter of a century's astronomical labor by the eminent Director; and gives full details concerning the instruments, the methods of observation and reduction, as also the positions resulting from each individual observation; and finally, a catalogue showing the deduced places for 1840.0, together with the precession, its secular variation, and the comparison with other standard catalogues, especially those of BRADLEY and PIAZZI.

The values adopted for the position of the Observatory are,

N. Latitude, $54^{\circ} 21' 12''.70$

Longitude, $0^{\text{h}} 26^{\text{m}} 35''.47$ W. from Greenwich.

A periodic motion of the hill upon which it is situated has been deduced, both by means of the transit-instrument and from the mural circle, and may be represented by supposing the ground to have an annual movement of about $6''$ around an axis which makes an angle of $65^{\circ} 48'$ with the meridian;

the northern limit being reached in January or February, and the southern in August or September.

The instruments of the Armagh Observatory have been described, and sundry investigations of probable errors and of corrections given, by Dr. ROBINSON, in the *Transactions of the Royal Astronomical Society* and of the *Royal Irish Academy*. He shows the probable error of the observed polar distance to be practically independent of any error in reading the microscopes, and somewhat less than $0''.5$ at the zenith, increasing to about $0''.6$ for *Polaris* and reaching $1''.00$ at a zenith distance between 55° and 60° South. The amount found by Dr. ROBINSON to be referable to atmospheric tremors in a direction normal to the meridian is $0''.57$ at the zenith, which seems sufficient to account for the whole of the error.

The number of observations of each coördinate of each star varies very considerably. The original plan contemplated five determinations with both instruments, but the average number appears to be between three and four.

The Introduction to the Observations contains a table of proper-motions, obtained from the differences of the Armagh Catalogue with those of BRADLEY, PIAZZI, LALANDE, and GROOMBRIDGE, for those cases in which the comparison shows a difference of $0''.5$ in right-ascension, or $5''$ in declination.

G.

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NEW WORK.

THE ASTRONOMICAL JOURNAL.

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CAMBRIDGE, 1860, APRIL 27.

NO. 13.

EPHEMERIS OF HESTIA FOR THE OPPOSITION IN 1860.

By JAMES C. WATSON.

THE elements upon which the ephemeris is based are the following:—

Epoch = 1857, Sept. 19.5, Washington M. T.

$M = 337^{\circ} 54' 26''.79$
 $\pi = 355 \ 8 \ 20.50 + 50.23 \ (t - 1857)$
 $\Omega = 181 \ 23 \ 58.92 + 50.42 \ (t - 1857)$
 $i = 2 \ 17 \ 54.72 - 0.46 \ (t - 1857)$
 $q = 9 \ 45 \ 46.95$
 $\log \alpha = 0.4048865$
 $\log \mu = 2.9426768$
 $\mu = 876''.348489$

These elements have been derived from the observations at the oppositions in 1857 and 1859, and satisfy the normal places in the following manner:—

Date.	δx	δy	δz
1860, March 29.5	−0.0034760	+0.0080981	+0.0033086
April 18.5	−0.0038990	+0.0081365	+0.0033316
May 8.5	−0.0043264	+0.0081351	+0.0033578

The ephemeris is the following, and is referred to the apparent equinox of the date:—

EPHEMERIS FOR WASHINGTON MEAN MIDNIGHT.

1860.	$\odot \alpha$	$\odot \delta$	Log Δ	1860.	$\odot \alpha$	$\odot \delta$	Log Δ
March 29	^h 12 ^m 44 ^s 48.75	− ^o 1 ['] 10 ^{''} 31.1	0.29002	April 11	^h 12 ^m 33 ^s 51.88	− ^o 2 ['] 51 ^{''} 53.3	0.29162
30	12 43 57.57	4 4 22.9	0.28976	12	12 33 3.71	2 46 6.9	0.29219
31	12 43 6.29	3 58 14.3	0.28956	13	12 32 16.12	2 40 24.6	0.29282
April 1	12 42 14.97	3 52 5.8	0.28942	14	12 31 29.15	2 34 46.8	0.29351
2	12 41 23.67	3 45 57.5	0.28934	15	12 30 42.86	2 29 13.6	0.29426
3	12 40 32.47	3 39 49.8	0.28934	16	12 29 57.30	2 23 45.6	0.29506
4	12 39 41.38	3 33 43.1	0.28940	17	12 29 12.51	2 18 22.8	0.29593
5	12 38 50.46	3 27 37.8	0.28953	18	12 28 28.53	2 13 5.8	0.29685
6	12 37 59.78	3 21 34.1	0.28972	19	12 27 45.45	2 7 54.9	0.29783
7	12 37 9.42	3 15 32.5	0.28997	20	12 27 3.25	2 2 50.3	0.29886
8	12 36 19.40	3 9 33.3	0.29028	21	12 26 22.00	1 57 52.2	0.29995
9	12 35 29.77	3 3 36.8	0.29067	22	12 25 41.71	1 53 0.8	0.30109
10	12 34 40.58	2 57 43.3	0.29111	23	12 25 2.41	1 48 16.5	0.30228

1860.	(46) α	(46) δ	Log Δ	1860.	(46) α	(46) δ	Log Δ
	^h ^m ^s	^o ['] ["]			^h ^m ^s	^o ['] ["]	
April 24	12 24 24.16	—1 43 39.3	0.30351	May 1	12 20 27.92	—1 14 57.2	0.31345
25	12 23 46.97	1 39 9.6	0.30481	2	12 19 58.94	1 11 24.0	0.31504
26	12 23 10.88	1 34 47.4	0.30614	3	12 19 31.20	1 7 59.5	0.31666
27	12 22 35.93	1 30 33.2	0.30752	4	12 19 4.73	1 4 44.1	0.31833
28	12 22 2.16	1 26 26.9	0.30894	5	12 18 49.56	1 1 37.9	0.32004
29	12 21 29.55	1 22 28.8	0.31040	6	12 18 35.81	0 58 41.0	0.32179
30	12 20 58.13	1 18 38.9	0.31191	7	12 18 23.41	—0 55 53.6	0.32357

The planet will be of the 12.13 magnitude.

Ann Arbor, 1860, March 28.

APPARENT RIGHT-ASCENSIONS OF THE MOON'S LIMB, AND OF MOON-CULMINATING STARS.

OBSERVED WITH THE TRANSIT-INSTRUMENT OF THE OBSERVATORY, WASHINGTON.

[Communicated by Commander M. F. MAURY, U. S. N.]

Date.	Name of Object.	No. of Threads.	Apparent α		Date.	Name of Object.	No. of Threads.	Apparent α	
			Observed	Computed				Observed	Computed
1859.			^h ^m ^s	^s	1859.			^h ^m ^s	^s
Jan. 12	101 <i>Piscium</i>	10	1 28 11.892		Feb. 14	53 <i>Geminorum</i>	25	7 7 11.095	
12	D I. Limb	15	1 45 49.826	49.95	14	<i>i Geminorum</i>	25	7 17 0.460	
12	β <i>Arietis</i>	10	1 46 52.040		14	D I. Limb	25	7 43 14.466	14.53
12	B. A. C. 607	25	1 51 47.175		14	ψ^2 <i>Cancr</i>	5	8 1 59.905	
13	<i>i Arietis</i>	15	1 49 39.713		14	λ <i>Cancr</i>	5	8 12 11.403	
13	α <i>Arietis</i>	15	1 59 14.583		14	γ <i>Cancr</i>	15	8 35 9.777	
13	θ <i>Arietis</i>	15	2 10 18.057		16	π^2 <i>Cancr</i>	25	9 7 29.047	
13	D I. Limb	14	2 41 6.533	6 36	16	83 <i>Cancr</i>	5	9 11 8.916	
15	α <i>Tauri</i>	15	4 27 51.662		16	ξ <i>Leonis</i>	10	9 24 23.004	
15	τ <i>Tauri</i>	13	4 33 48.903		16	D I. Limb	25	9 47 59.392	59.74
15	D I. Limb	25	4 48 59.266	59.25	16	α <i>Leonis</i>	25	10 0 54.043	
17	κ <i>Aurigæ</i>	5	6 6 25.668		March 12	D I. Limb	15	6 9 47.027	47.02
17	48 <i>Aurigæ</i>	15	6 19 32.550		12	μ <i>Geminorum</i>	15	6 14 27.436	
17	49 <i>Aurigæ</i>	15	6 26 21.439		12	49 <i>Aurigæ</i>	15	6 26 20.932	
17	D I. Limb	25	7 10 39.788	40.37	16	B. A. C. 3345	25	9 40 0.649	
17	ν <i>Geminorum</i>	25	7 27 16.265		16	ν <i>Leonis</i>	25	9 51 40.571	
17	κ <i>Geminorum</i>	15	7 35 58.262		16	α <i>Leonis</i>	25	10 0 54.071	
18	ν <i>Geminorum</i>	15	7 27 16.171		16	D I. Limb	25	10 16 36.397	36.32
18	κ <i>Geminorum</i>	15	7 35 58.273		16	45 <i>Leonis</i>	5	10 20 14.268	
18	λ <i>Cancr</i>	15	8 12 11.224		16	ρ <i>Leonis</i>	25	10 25 25.550	
18	D II. Limb	15	8 21 4.219	4.09	April 9	D I. Limb	15	6 55 39.004	39.30
18	η <i>Cancr</i>	15	8 24 35.350		9	<i>i Geminorum</i>	15	7 16 59.644	
18	γ <i>Cancr</i>	15	8 35 9.650		9	ν <i>Geminorum</i>	15	7 27 15.542	
19	η <i>Cancr</i>	25	8 24 35.345		12	ν <i>Leonis</i>	15	9 50 40.339	
19	γ <i>Cancr</i>	15	8 35 9.623		12	D I. Limb	15	9 55 10.728	11.01
19	δ <i>Cancr</i>	15	8 36 42.283		12	α <i>Leonis</i>	15	10 0 53.860	
19	83 <i>Cancr</i>	25	9 11 8.642		16	ψ <i>Virginis</i>	5	12 47 3.861	
19	D II. Limb	25	9 33 49.105	48.76	16	g <i>Virginis</i>	15	13 0 33.358	
19	ν <i>Leonis</i>	25	9 50 40.135		16	α <i>Virginis</i>	15	13 17 48.727	
19	η <i>Leonis</i>	25	9 59 40.571		16	D I. Limb	15	13 22 58.256	58.30
Feb. 10	ζ <i>Arietis</i>	15	3 6 48.788		16	69 <i>Virginis</i>	15	13 19 58.843	
10	ι' <i>Arietis</i>	15	3 13 6.255		May 12	D I. Limb	15	12 12 48.099	48.14
10	D I. Limb	15	3 17 41.175	41.07	12	f <i>Virginis</i>	14	12 29 34.129	
10	11 <i>Tauri</i>	15	3 32 22.348		12	28 <i>Virginis</i>	13	12 34 42.768	
10	η <i>Tauri</i>	15	3 39 7.529		13	f <i>Virginis</i>	25	12 29 34.144	

Date.	Name of Object.	No. of Threads.	Apparent α		Date.	Name of Object.	No. of Threads.	Apparent α	
			Observed	Computed				Observed	Computed
1859.			h m s	s	1859.			h m s	s
May 13	28 <i>Virginis</i>	25	12 34 42.735		June 17	ρ <i>Capricorni</i>	25	20 20 52.188	
13	$\mathcal{D}$ l. Limb	25	13 3 10.249	10.12	July 9	α^2 <i>Librae</i>	25	14 43 7.889	
13	58 <i>Virginis</i>	20	13 10 6.724	.	9	20 <i>Librae</i>	15	14 55 52.545	
13	α <i>Virginis</i>	25	13 17 48.750		9	ι' <i>Librae</i>	15	15 4 14.475	
June 9	η <i>Virginis</i>	15	12 12 43.725		9	$\mathcal{D}$ l. Limb	25	15 7 30.455	30.59
9	$\mathcal{D}$ l. Limb	15	12 47 16.339	16.55	9	39 <i>Librae</i>	25	15 28 31.729	
9	58 <i>Virginis</i>	15	13 10 6.589		9	42 <i>Librae</i>	15	15 32 0.517	
9	α <i>Virginis</i>	15	13 17 48.712		9	λ <i>Librae</i>	15	15 45 12.597	
11	86 <i>Virginis</i>	15	13 38 28.352		11	$\mathcal{D}$ l. Limb	25	16 59 37.512	37.52
11	89 <i>Virginis</i>	15	13 42 15.539		11	A' <i>Ophiuchi</i>	25	17 6 44.825	
11	$\mathcal{D}$ l. Limb	15	14 30 11.095	11.28	11	θ <i>Ophiuchi</i>	25	17 13 25.129	
11	20 <i>Librae</i>	15	14 55 52.662		11	d <i>Ophiuchi</i>	25	17 18 25.379	
11	ι' <i>Librae</i>	15	15 4 14.497		12	θ <i>Ophiuchi</i>	10	17 13 25.110	
11	β' <i>Scorpii</i>	25	15 57 17.988		12	d <i>Ophiuchi</i>	5	17 18 25.330	
17	h^2 <i>Sagittarii</i>	25	19 28 11.082		12	$\mathcal{D}$ l. Limb	25	17 56 22.386	22.59
17	f <i>Sagittarii</i>	25	19 38 11.556		12	μ' <i>Sagittarii</i>	25	18 5 23.944	
17	$\mathcal{D}$ ll. Limb	25	20 4 50.706	50.59	12	δ <i>Sagittarii</i>	5	18 12 2.365	
17	σ <i>Capricorni</i>	25	20 11 18.651		12	λ <i>Sagittarii</i>	20	18 19 20.365	

The clock-stars used are those of the *British Nautical Almanac* for the mean equinox of 1860.0. The moon's computed place is taken from the *American Ephemeris*.

REAPPEARANCE OF *U GEMINORUM*.

U Geminorum has again appeared, suddenly as usual. On the 14th instant I examined the region, and was satisfied that the variable was as low as the 12 magnitude. Since then several estimates have been made, with the following comparison-stars, most of which are those originally selected for employment at the Dudley Observatory, in Albany.

1860.			
Name.	α	δ	Mag.
a	$7^{\text{h}} 46.9^{\text{m}}$	$+22^{\circ} 2'$	8.6
b	48.3	22 15	9.1
c	48.1	22 12	

1860.			
Name.	α	δ	Mag.
d	$7^{\text{h}} 47.6^{\text{m}}$	$+21^{\circ} 47'$	9.6
e	46.4	22 13	10.5
f	49.0	22 5	9.2
g	47.0	23 0	9.4
h	$7^{\text{h}} 48.5^{\text{m}}$	$+22^{\circ} 40'$	

I give my own estimate of the magnitude of the comparison-stars, which have as yet been observed only a few times. The following are the comparisons of the variable with them and measurements of the difference of magnitude:—

1860, April 17	$9^{\text{h}} 40^{\text{m}}$	$U = e 4 b; > e$ by $0^{\text{M}}.70$; $< b$ by $0^{\text{M}}.67$
	12 30	$= e 6 b = h 6 g$
18	7 45	$= f = g 2 a$
	11 30	$= e 9.5 b = d 5 a = f; > g$ by $0^{\text{M}}.39$; $> d$ by $0^{\text{M}}.68$; $< a$ by $0^{\text{M}}.39$
	19 8 10	$= f = c 2 a$
	24 10 30	$= c = e 9 b = d 2^{\text{M}}.5 a$
	11 45	$< a$ by $0^{\text{M}}.77$; $< c$ by $0^{\text{M}}.21$

The following observations of the last maximum may be useful, in addition to those made by Mr. GOLDSCHMIDT.

1859, November 16	$12^{\text{h}} 0^{\text{m}}$	$U = e 8 b = e 9 c = d 1 a$
	17 12 55	$= e 6 b = e 8 c$
	19 10 25	$= e 1.5 b$
	11 15	$= e 0.5 b$
	20 13 30	$=$ about 12 magnitude.

1860, April 25.

G. SEARLE.

FROM A LETTER OF DR. MOESTA TO THE EDITOR.

National Observatory, Santiago de Chile, 1860, February 15.

PERMIT me to enclose to you, with these lines, the determinations of position which I made at this observatory for the Great Comet 1858, V., thinking that you may be disposed to give them a place in your *Astronomical Journal*. The observations were made, as you will perceive, partly with the filar-micrometer, and partly with the ring-micrometer. For the latter, I have indicated, in a special column, by the sign + or — whether the comet and the comparison-star were both of them observed, either in the northern or southern part of the ring, — a circumstance which may be of importance in the formation of normal places. The positions of the comparison-stars I have determined with the meridian-circle, — those stars from the *Nautical Almanac* for 1859 whose declination is less than 30° having almost exclusively been employed as clock-stars, — by applying to their right-ascensions small corrections corresponding to those given on page xxviii

of the *Greenwich Observations* for 1855. Only in a few special cases have other stars been used, and even then, only those whose right-ascensions are given in the above-mentioned passage of the Greenwich volume, and which serve there also as clock-stars.

All the observations were made on the *Cerro de Santa Lucia*, in the old and inadequate position of the instruments; but I have the gratification now of announcing that the new edifice is so far advanced, that the transfer of the instruments will take place next month. Our astronomical activity will then be far more efficient than has hitherto been possible. And I may look forward to this with all the more confidence, inasmuch as, after various trials and annoyances, I have at last enlisted the assistance of Mr. RICHARD SCHUMACHER, from Altona, who has been actively and zealously engaged here since October last.

C. W. MOESTA.

OBSERVATIONS OF THE GREAT COMET, V., 1858, MADE AT THE OBSERVATORY OF SANTIAGO DE CHILE.

BY C. W. MOESTA, DIRECTOR.

OBSERVATIONS WITH THE FILAR-MICROMETER.

Comparison Star.	Date.	Santiago Mean Time.	$\Delta \alpha$	Number of Comp.	$\Delta N. P. D.$	Number of Observations.	Log fact. Parall.	
			$\begin{smallmatrix} \text{h} & \text{m} & \text{s} \\ \text{—} & \text{—} & \text{—} \end{smallmatrix}$		$\begin{smallmatrix} \text{h} & \text{m} & \text{s} \\ \text{—} & \text{—} & \text{—} \end{smallmatrix}$		α	δ
	1858.							
1	October 30	7 52 9.3	+ 13.29	4			9.7640	
1	30	7 58 17.9			+2 15.62	5		0.3259
2	31	8 22 18.8	+ 44.67	7			9.7865	
2	31	8 35 57.4			—7 9.0	6		0.4437
2	31	8 47 20.3	+ 48.38	7			9.7949	
3	Nov. 2	7 32 28.6	—1 43.10	2			9.7602	
6	3	8 0 36.0	—3 38.85	8	—2 12.0	8	9.7884	0.2755
6	3	10 7 58.7	—3 18.51	4	+1 2.5	4	9.8009	0.6592
7	3	10 16 54.2	—4 46.63	1			9.7967	
4	4	7 59 17.1	+5 36.89	5	— 39.3	5	9.7820	0.2614
5	5	8 8 51.6	+4 7.18	10	—4 0.1	10	9.8022	0.2969
8	6	7 55 18.8	+4 19.55	6			9.7973	
8	6	7 57 16.8			+6 45.2	5		0.2338
9	9	7 34 45.0	+ 11.00	3			9.7940	
9	9	7 34 46.0			+6 18.7			0.0645
9	9	8 11 5.0	+ 15.86	9	+6 58.9	13	9.8191	0.2840
10	11	8 3 40.2	—2 3.71	19	—1 20.8	19	9.8224	0.2395
13	14	7 50 35.1	—3 53.93	8			9.8245	
13	14	7 51 42.1			— 58.4	9		0.1634
11	14	7 54 27.7	— 46.20	7			9.8274	
12	15	7 58 9.8	+1 9.50	14	+2 21.2	14	9.8307	0.1793
14	17	8 8 58.7	+ 41.53	5			9.8006	
14	17	8 8 19.8			— 38.7	6		9.6414
16	18	8 13 30.3	— 47.10	11			9.8500	

Comparison Star.	Date.	Santiago Mean Time.	$\Delta \alpha$	Number of Comp.	Δ N. P. D.		Number of Observations.	Log fact. Parall.	
			$\begin{smallmatrix} \nearrow & - & * \end{smallmatrix}$		$\begin{smallmatrix} \nearrow & - & * \end{smallmatrix}$			α	δ
	1858.	^h ^m ^s	^m ^s		ⁱ ["]				
16	Nov. 18	8 39 36.8			+8 9.4		11		0.4103
15	19	8 2 37.8	+2 44.45	11	+5 22.1		11	9.8525	0.2375
17	19	7 46 33.9	+1 27.25	4				9.8390	
19	20	8 25 7.2	+1 26.78	14	+ 52.5		14	9.8596	0.3547
21	22	8 11 18.8	-3 49.71	10	+1 9.0		10	9.8602	0.2959
20	24	8 0 12.5	+1 40.90	10	-4 13.2		10	9.8615	0.2426
24	27	8 6 47.4	-8 60.21	3	-6 26.0		3	9.8711	0.2966
23	30	8 30 37.5	+1 42.02	11				9.8823	
25	Dec. 2	8 8 50.5	+1 41.77	10	+2 33.2		10	9.8823	0.3383
26	3	8 4 59.1	+ 30.47	7	+1 23.1		11	9.8832	0.3288
28	3	8 34 45.8	-2 49.55	6				9.8876	
28	3	8 34 56.7			-3 57.6		6		0.4546
27	3	8 34 36.3	-2 18.12	4				9.8876	
28	4	8 10 3.2	- 44.95	12	+5 11.9		12	9.8865	0.3569
29	6	8 13 7.7			-2 45.2		7		0.3831
29	6	8 25 0.5	+ 27.53	6				9.8922	
29	6	8 51 39.1			-2 23.8		6		0.5371
30	7	8 20 50.5	+1 20.75	10	+ 32.6		10	9.9893	0.4227
31	8	8 33 32.3	-1 41.70	9				9.8947	
31	8	8 36 30.3			-4 23.3		7		0.4875
31	9	8 20 7.6			+3 40.9		14		0.4320
31	9	8 22 23.5	+ 21.10	8				9.8961	
32	10	8 39 8.1	+1 1.40	10	- 56.5		10	9.8965	0.5072
36	11	8 33 49.8	-13 18.24	3	-4 13.9		3	9.8985	0.4126
33	13	8 43 5.9	+3 1.18	11	- 49.1		11	9.8987	0.5358
34	15	8 33 12.8	+1 31.37	8	+2 6.2		8	9.9022	0.3682
35	16	8 37 39.2	-2 42.29	6				9.9023	
35	16	8 42 2.6			+ 23.6		4		0.5480
37	20	8 29 41.3	- 31.97	10	-3 29.8		10	9.9070	0.5305
37	21	8 36 52.7	+1 27.53	6	+3 4.9		10	9.9059	0.5582
38	22	8 44 13.7	+ 43.68	6				9.9040	
38	22	8 44 29.6			+ 8.0				0.5853

OBSERVATIONS WITH THE RING-MICROMETER.

Comparison Star.	Date.	Santiago Mean Time.	$\Delta \alpha$	Number of Comp.	Δ N. P. D.		Number of Comp.	Log fact. Parall.	
			$\begin{smallmatrix} \nearrow & - & * \end{smallmatrix}$		$\begin{smallmatrix} \nearrow & - & * \end{smallmatrix}$			α	δ
	1858.	^h ^m ^s	^m ^s		ⁱ ["]				
39	Dec. 27	8 49 18.1	+4 11.32	3				9.9031	
40	27	9 8 18.6			+25 39.8		3		0.6676
41	28	8 50 54.5	+ 37.73	4				9.9024	
41	28	8 45 53.4			+ 2 18.8	±	4		0.6176
43	29	8 34 25.8	-2 9.87	4	- 1 37.6	-	3	9.9102	0.6531
44	29	8 58 26.3						9.9110	
43	30	8 32 59.9	- 13.52	4	+ 39.8	-	4		0.6332
43	30	8 48 35.4			+ 27.9	+	3		0.6574
43	30	8 58 36.0						9.9100	
43	31	8 35 45.3	+1 45.59	3	-27 16.9		3		0.6617
42	31	8 58 31.9							
	1859.								
45	Jan. 2	8 30 49.1	+ 35.15	4				9.9126	
45	2	8 47 25.2			- 41.3	-	4		0.6463
46	3	8 39 8.5	+2 27.67	4				9.9087	
46	3	8 59 48.9			- 1 30.3	+	2		0.6768
46	3	9 8 31.5			- 1 0.2	-	2		0.6955
49	5	8 47 24.6	+2 13.48	4				9.9038	
49	5	9 8 38.1			- 1 12.3	-	3		0.7032
49	5	9 20 48.6			- 1 38.1	+	2		0.7270
50	7	8 42 38.1	- 48.75	3				9.9065	
50	7	9 0 31.0			- 3 1.5	-	3		0.6898

Comparison Star.	Date.	Santiago Mean Time.	$\Delta\alpha$ — *	Number of Comp.	$\Delta N. P. D.$ — *	Number of Comp.	Log fact. Parall. α	δ
	1859.	^h ^m ^s	^m ^s		[°] ['] ["]			
51	Jan. 8	8 37 20.5	— 28.86	3	— 54.1	— 4	9.9096	0.6776
51	8	8 51 10.1	+	4	— 2 49.5	— 4	9.9081	0.6972
52	10	8 39 12.1	+2 11.56	3	+24 27.4	3	9.9042	0.7094
52	10	8 56 40.1	+2 7.55	4	— 2 46.2	— 1	9.9018	0.7643
53	11	8 41 23.1	+4 8.95	1	+	3	9.8931	0.7111
54	11	9 0 50.0	— 51.08	4	— 60.0	— 4	9.9037	0.7348
54	20	8 42 6.2	+	2	—26 9.6	3	9.8845	
54	21	8 58 22.3	—1 13.19	3			9.8858	
54	21	9 13 26.1	+ 47.29	4			9.8798	
55	22	8 50 13.2	+4 48.20	3			9.9062	
56	22	9 0 27.6	— 48.86	2	— 4.6	+	6	0.7463
57	24	8 50 39.9	+	0.50	+27 0.1	3	9.8795	0.7712
57	24	8 37 47.1	—4 42.94	3	+26 35.4	3	9.8737	0.8024
58	24	9 7 26.9	—2 41.42	4			9.8737	
58	25	8 55 15.0	—4 56.26	4			9.8521	
58	26	8 53 47.7	—2 53.83	3			9.8521	
58	28	8 57 14.9	—1 36.67	3	+25 49.7	5		0.7439
60	29	8 31 40.0	—2 41.42	4	— 1 2.6	— 4		0.7836
60	29	8 48 3.4	—2 2.41	4	+27 6.7	4		0.7395
59	29	9 2 42.7	—2 2.41	4			9.8637	
62	31	8 54 46.0	—0 2.41	3	+26 0.1	4	9.8986	
61	31	9 19 54.4	—2 33.89	3			9.8999	
62	Feb. 1	8 58 26.7	— 53.99	4	—21 58.7	2	9.8886	0.7863
64	1	8 58 26.7	—3 30.16	3			9.9108	
64	2	9 12 46.7	—1 22.22	3	—25 2.5	1	9.9124	0.7914
64	2	9 12 46.7	+4 5.88	4			9.9064	
63	2	8 39 45.2	+6 13.87	2	+ 1 40.1	+	2	0.7910
63	2	8 43 36.9	+2 0.53	2			9.9267	
66	3	8 35 29.0						
65	3	9 3 55.1						
65	4	8 35 23.1						
69	5	8 33 33.1						
64	5	8 59 59.3						
70	7	8 41 28.7						
73	21	8 15 37.8						
71	21	8 36 42.2						
73	22	8 13 57.6						
72	22	8 28 34.8						
71	23	8 18 16.5						
71	24	8 9 34.8						
71	24	8 31 32.1						
75	March 1	8 0 37.2						

The observed differences in Right-ascension and North Polar Distance are corrected for refraction and proper-motion of the comet.

C. W. MOESTA.

MEAN POSITIONS FOR 1859.0 OF THE COMPARISON-STARS.

OBSERVED WITH THE MERIDIAN-CIRCLE.

	No.	Mag.	α 1859.0.	No. of Obs.	North Polar Distance, 1859.0.	No. of Obs.		No.	Mag.	α 1859.0.	No. of Obs.	North Polar Distance, 1859.0.	No. of Obs.
			^h ^m ^s		[°] ['] ["]					^h ^m ^s		[°] ['] ["]	
Lac. 7534	1	8	17 50 43.34	4	129 39 2.30	2		9	7 1 1/2	18 27 55.17	6	135 34 42.03	6
Lac. 7600	2	8	54 42.65	4	130 38 9.29	4		10	8 1 1/2	36 16.93	5	136 31 14.43	5
	3	7	18 5 18.46	3	131 56 25.90	3	Lac. 7889	11	6 1 1/2	43 28.40	3	137 27	
	4	7	5 40.40	3	133 12 19.01	3		12	9	44 14.94	2	137 49 43.71	2
	5	6	10 47.92	3	133 49 48.16	2		13	7	46 35.73	3	137 33 59.26	3
	6	9	11 12.08	4	132 37 39.31	4	Tayl. 8704	14	7	49 58.95	2	138 28 17.46	2
	7	7	12 41.17	1	132 39			15	8	52 58.63	2	138 54 27.69	2
B.A.C. 6228	8	6	14 2.64	4	134 10 30.08	3	Lac. 7959	16	6 1 1/2	54 0.21	2	138 36 13.99	2

	No.	Mag.	α 1859.0.	No. of Obs.	North Polar Distance, 1859.0.	No. of Obs.		No.	Mag.	α 1859.0.	No. of Obs.	North Polar Distance, 1859.0.	No. of Obs.
			^h ^m ^s		^o ['] ["]					^h ^m ^s		^o ['] ["]	
Tayl. 8889	17	8	18 54 14.82	1	138 51 3.54	1		47	9	20 27 24.76	1	145 36 "	
	18	8	56 8.89	1	139 12 32.62	1		48	8½	28 9.57	2	145 36 41.89	2
	19	9½	56 46.05	3	139 14 16.41	2		49	10	31 23.81	4	145 36 30.66	2
	20	8	19 5 57.47	3	140 13 35.56	2		50	10	38 21.56	4	145 43 23.42	2
	21	8½	6 49.27	5	139 42 12.71	5		51	9½	39 58.73	3	145 53 23.14	2
	22	6½	14 16.08	4	141 22			52	8	43 12.10	3	146 6 49.19	3
	23	9½	19 23.09	2	141 16 0 28	2	Lac. 8605	53	6½	45 35.64	3	145 45 12.47	3
	24	7	23 26.79	2	140 51 43.20	1	Tay. 9781	54	7	21 1 2.48	2	147 5 12.43	2
	25	10	23 39.32	3	141 34 36.24	2		55	9	8 3.26	2	147 18 3.90	2
	26	9½	26 57.89	2	141 44 59.50	2		56	9	10 45.75	3	147 12 15.77	2
	27	6½	29 48.82	4	141 51 50.86	1		57	10	11 10.07	1	147 26 48.55	1
	28	6½	30 20.47	3	141 50 41.65	2	Tay. 9894	58	7	14 20.60	3	147 51 22.09	3
	29	10	33 20.27	4	142 16 12.76	3		59	8½	20 26.30	4	147 29 5.95	2
	30	10	34 31.18	4	142 21 32.34	2		60	8	21 55.21	2	147 55 14.83	2
	31	8	39 38.42	3	142 31 56.38	3		61	8	23 22.89	1	147 42 4.33	2
	32	10	41 2.15	3	142 47 29.19	2	Tay. 10026	62	7	29 54.81	2	148 4 24.05	2
	33	10	45 9.20	2	143 10 11.53	2		63	7½	30 52.31	4	148 22 25.10	2
	34	8	50 37.89	4	143 21 41.46	4	Tay. 10050	64	7	32 9.16	1	148 15 1.52	1
	35	8	56 52.29	4	143 30 27.46	3		65	8½	33 18.34	1	148 32 14.82	1
	36	6½	57 23.23	2	142 58 42.98	2	Tay. 10060	66	6½	33 40.		148 0 28.20	1
	37	8½	20 2 38.38	4	144 1 20.85	3	Tay. 10064	67	7	33 57.47	3	147 55 21.35	2
	38	8½	5 22.36	2	144 10 49.91	2		68	8½	37 29.30	2	148 38 33.17	2
	39	8	11 46.46	4	144 42 17.70	4		69	9	37 51.40	1	148 40	
	40	8	15 50.41	1	144 16 30.31	1	B.A.C. 7576	70	7	40 18.13	4	148 57 18.26	4
	41	8½	17 18.18	2	144 45 35.68	2	α Tucanæ	71	3	22 8 48.31	2	150 57 36.81	2
	42	8½	18 51.59	2	145 32 57.39	2		72	7	11 13.		151 8 11.00	
	43	8½	22 1.81	4	144 59 16.69	4		73	8	12 6.08	4	150 39 16.98	4
	44	9½	23 3.59	2	141 55 52.30		Lac. 9156	74	7	23 46.74	1	151 9 27.50	1
	45	9½	27 7.65	2	145 18 29.95	2		75	8½	23 53.89	3	151 32 27.41	3
	46	9½	27 13.29	1	145 24 33.43	2							

3. The α in LACAILLE'S Catalogue is erroneous by 2^m.

14. The comparison with the Catalogue indicates an annual proper-motion in α of $-0''.06$.

70. The position in the B. A. Catalogue is erroneous.

The N. P. Distance of 44 and 72 have been obtained by the equatorial, taking No. 43 and 74 as comparison-stars.

TANGENT ($45^\circ \pm \omega$).

THE accurate determination of $\tan \omega$ from $\tan (45^\circ \pm \omega)$, especially useful in formulas given in Sections 8 and 89 of GAUSS'S *Theoria Motus*, may be facilitated by the following table.

ξ	$[\psi]$	ξ	$[\psi]$	ξ	$[\psi]$	ξ	$[\psi]$
0.000	0.0611857	0.010	0.0611665	0.020	0.0611089	0.030	0.0610130
1	855	1	625	1	1011	1	10013
2	849	2	581	2	0928	2	09892
3	840	3	533	3	0842	3	09768
4	826	4	481	4	0752	4	09639
5	809	5	425	5	0658	5	09507
6	788	6	366	6	0560	6	09371
7	763	7	302	7	0458	7	09231
8	734	8	235	8	0353	8	09087
9	702	9	164	9	0243	9	08940
						0.040	08788

Let $\xi = [\tan (45^\circ \pm \omega)]$

Then $[\tan \omega] = [\xi \psi]$.

The quantity $[\psi]$ may be computed with ease to 8 or 10 places by first computing $[\psi] = 9.283037 - [9.134] \xi^2$; when we shall have $[\psi] = \left(\frac{1}{2}M\right) - \xi^2 \psi$, in which M represents Modulus.

New York, 1860, April 18.

HENRY M. PARKHURST.

FIFTY-EIGHTH ASTEROID.

DR. LUTHER, of the Bilk Observatory, announces the discovery of a Fifty-eighth Asteroid, on the 24th March. The planet appeared of the 11 magnitude, and Dr. LUTHER obtained the following determinations:

1860, March 24	11 ^h 11 ^m	Bilk M. T.,	$\alpha = 180^{\circ} 29'$	$\delta = +2^{\circ} 51'$
	12 14		180 28.4	+2 51.5

The weather on the 25th was cloudy, so that the daily motion could not be accurately determined.

NEW WORK.

Astronomische Beobachtungen auf der Sternwarte zu Bonn angestellt und herausgegeben, von Dr. FR. W. A. ARGELANDER. Dritter Band. Bonner Sternverzeichniss, I. Section.—In this invaluable volume, the distinguished author gives the places of 110,985 stars brighter than the 10 magnitude between the limits -2° and $+20^{\circ}$, being the positions of those stars within these limits which appear upon the Bonn charts, and have been determined by the methods and according to the rules heretofore explained by Professor ARGELANDER, and known to the readers of this Journal.

The plan of the work contemplated the cataloguing and mapping of every star to the 9 magnitude inclusive, of as many as possible of the brighter portion of the class known as $(9-10)^M$, and of such others belonging to this class as circumstances might permit. The magnitudes are given to tenths, the right-ascensions to tenths of seconds of time, the declinations to tenths of minutes; the respective errors to be apprehended being not more than half a magnitude, $0^{\circ}.70$ in right-ascension, and $0^{\circ}.44$ in declination, and the most trustworthy values for the probable errors being $0^M.15$, $\pm 0^{\circ}.50$, and $\pm 0^{\circ}.19$.

The preface to the present volume contains a most instructive and interesting description in detail of the mode of observation, record, and reduction, — as well as a full discussion of the results and comparison of them with other Catalogues, especially the Zones of BESSEL and LALANDE. No adequate compendium of it can be given in the limited space of this Journal; it must suffice to refer our readers to the fountain-head, since no practical astronomer can afford to dispense with the work.

The Catalogue is arranged in zones of declination, 1° in

width; the stars of each zone being arranged and numbered in the order of their right-ascension. The page contains five compound columns, each consisting of sixty stars, grouped by tens, so that a full page will comprise the places of 300 stars. The necessity of cumbering the page with figures for mere numerical reference is avoided by this simple arrangement, and all the ends of numeration are attained by the citation at the head of the columns of the numbers of the first and of the last star contained in it. Each column has four subdivisions, which are separated by rules, and contain respectively the magnitude, right-ascension, declination, and reference-letter. This latter is given whenever the star has been determined by Professor ARGELANDER with the meridian-circle, or when it occurs in BESSEL's Zones, the *Histoire Céleste*, or the Catalogues of STRUVE, PIAZZI, or RÜMKE.

The number of stars given corresponds to somewhat more than 14 to each degree square; and in some portions of the sky, near the Milky Way, as many as 30 stars are sometimes found to enter the field of the instrument within a single minute.

At the commencement, in the spring of 1852, of the series of observations upon which this Catalogue and the charts are founded, Professor ARGELANDER was aided by Mr. THORMANN, who continued upon the work until the autumn of the ensuing year, but whose health suffered so much from the exhausting character of the labors, that he was unhappily compelled to desist. In the spring of 1853, Professor SCHOENFELD, and in the autumn of the same year Dr. KRÜGER began their labors upon the "*Durchmusterung*," or "stellar census," as it may well be called, and since that time these accomplished astronomers have borne their part in this magnificent enterprise, with the energy, zeal, and success so well known to astronomers.

G.

(To be continued.)

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THE ASTRONOMICAL JOURNAL.

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CAMBRIDGE, 1860, MAY 31.

NO. 14.

EPHEMERIS OF VIRGINIA FOR THE OPPOSITION IN 1860.

By JOHN N. STOCKWELL.

THE following ephemeris is derived from the elements given in N^o. 116 of the *Astronomical Journal*. The intensity of the light during the present opposition is about 0.04, — the unit of brightness being that of the time of discovery. On account of its faintness it will be difficult, if not impossible, to find the planet. The ephemeris is referred to the mean equinox of 1860.0.

1860.		(50) α	(50) δ	Log Δ	Log r	1860.		(50) α	(50) δ	Log Δ	Log r
April	30	206° 31' 48.2	—8° 20' 41.2	0.36760	0.52127	May	27	202° 14' 32.7	—6° 40' 4.3		
May	1	206 19 50.3	8 15 52.2				28	202 8 29.6	6 37 51.9	0.39558	0.51669
	2	206 7 59.6	8 11 6.5				29	202 2 43.9	6 35 46.9		
	3	205 56 16.7	8 6 24.4				30	201 57 16.0	6 33 49.5		
	4	205 44 42.0	8 1 46.0	0.36943	0.52066		31	201 52 5.8	6 31 59.6		
	5	205 33 16.1	7 57 11.5			June	1	201 47 13.7	6 30 17.3	0.40187	0.51598
	6	205 21 59.5	7 52 41.3				2	201 42 39.5	6 28 42.6		
	7	205 10 52.7	7 48 15.8				3	201 38 23.0	6 27 15.6		
	8	204 59 56.1	7 43 54.7	0.37211	0.52004		4	201 31 24.6	6 25 56.1		
	9	204 49 10.0	7 39 38.6				5	201 30 44.1	6 24 44.2	0.40852	0.51524
	10	204 38 35.5	7 35 27.5				6	201 27 21.5	6 23 40.0		
	11	204 28 13.0	7 31 21.8				7	201 24 17.0	6 22 43.5		
	12	204 18 2.5	7 27 21.6	0.37548	0.51940		8	201 21 30.7	6 21 54.4		
	13	204 8 4.8	7 23 26.9				9	201 19 2.7	6 21 12.9	0.41547	0.51449
	14	203 58 20.2	7 19 38.1				10	201 16 52.8	6 20 39.0		
	15	203 48 49.5	7 15 55.4				11	201 15 0.9	6 20 12.7		
	16	203 39 32.6	7 12 18.8	0.37960	0.51875		12	201 13 27.3	6 19 54.2		
	17	203 30 30.0	7 8 48.4				13	201 12 11.7	6 19 43.3	0.42266	0.51372
	18	203 21 42.2	7 5 24.7				14	201 11 14.0	6 19 39.7		
	19	203 13 9.9	7 2 7.7				15	201 10 34.4	6 19 43.5		
	20	203 4 52.9	6 58 57.5	0.38437	0.51808		16	201 10 13.0	6 19 54.8		
	21	202 56 51.5	6 55 54.0				17	201 10 9.5	6 20 13.6	0.43002	0.51294
	22	202 49 6.5	6 52 57.7				18	201 10 23.7	6 20 39.6		
	23	202 41 38.1	6 50 8.5				19	201 10 55.7	6 21 13.0		
	24	202 34 26.2	6 47 26.5	0.38972	0.51740		20	201 11 45.5	6 21 53.7		
	25	202 27 31.1	6 44 51.7			June	21	201 12 52.8	—6° 22' 41.8	0.43751	0.51214
May	26	202 20 53.2	—6° 42' 24.3								

FROM A LETTER OF PROF. CASWELL TO THE EDITOR.

Providence, 1860, April 30.

I INCLOSE the following memorandum of observations of the occultation of *Venus* on the 24th instant, regretting very much that, from having a small field of view and misjudging as to the exact point of reappearance on the moon's limb, I failed to obtain the emersion with any exactness. For time I used a reliable chronometer, which was also

compared with my clock. I used my four-inch clock telescope, with a power which, under favorable circumstances, shows the principal division in the ring of *Saturn*. The disc of *Venus* was large and sharply defined.

The wind was gusty, which occasionally produced a tremor in the planet, but the air was perfectly clear.

The first contact occurred at $8^h 41^m 39^s$ Providence M. T.
Total immersion, $8^h 42^m 25^s$ " "

As the time for the reappearance approached, I carefully watched the point where I expected the planet would be seen. At $9^h 28^m 50^s$, not seeing it, I changed my field of view a little, and discovered it entirely separated from the moon's bright limb. Judging as well as I could from the rate of approach at its immersion and the time of the planetary disc passing the moon's dark limb, I concluded that the total emersion must have taken place at least 10^s before that time, making the total emergence at $9^h 28^m 40^s$.

Two of my pupils made observations with a four-inch telescope and low power, which but imperfectly defined the disc of the planet, but embraced the entire moon in the field of view.

Their results were as follows:—

First contact, $8^h 41^m 56^s$ Providence M. T.
Total immersion, $8^h 42^m 27^s$ " "
First reappearance, $9^h 28^m 21^s$ " "

The time in the observations was taken from a watch, compared before and after the occultation with the clock. From some little uncertainty in the time, and the low power of the telescope, these observations are probably somewhat wanting in exactness.

In my own observation the probable error for the first contact could hardly be more than 1^s . For the total immersion there was no interval of doubt.

I was particularly struck with one circumstance, and am curious to know whether other observers noticed the same thing.

As the moon approached the planet, the outline of the moon's limb became obscured and indistinct; it was impossible to anticipate the instant of contact by watching the gradual approach, and it was necessary to judge by the actual change in the form of the disc.

The first thing which I observed was a momentary tremor in the light from the edge of *Venus* nearest to the moon. In a second from that time the sharp outline of the disc was broken, and the occultation unmistakably commenced.

ALEXIS CASWELL.

OBSERVATIONS OF LEUCOTHEA AND THE OCCULTATION OF VENUS BY THE MOON, 1860, APRIL 24.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — Corrected for refraction.]

LEUCOTHEA.

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽³⁵⁾ — *	$\Delta\delta$	α ⁽³⁵⁾ 's apparent	δ
	h^m^s			m^s	^{s}	h^m^s	$^o' ''$
1860, Mar. 27	8 43 14.0	3	Weisse, X. 331	—1 29.79	+13 4.52	10 21 32.75	+12 33 40.94
28	8 13 3.9	8	" 331	—2 0.78	+11 33.24	10 21 1.75	12 32 9.71
29	9 37 50.9	4	" 331	—2 32.43	+9 42.72	10 20 30.09	12 30 19.17
30	8 13 21.9	6	" 331	—2 58.43	+7 57.14	10 20 4.08	12 28 33.70
Ap. 6	8 28 26.3	4	Rümker, 3198	—2 16.16	+10 17.85	10 17 33.05	12 11 45.77
11	7 53 41.6	12	3156	+1 51.44	—5 41.64	10 16 36.41	11 55 50.13
13	8 46 24.4	10	3156	+1 41.34	—12 58.32	10 16 26.27	11 48 33.57
14	8 27 32.9	9	3179	—1 39.84	—7 5.38	10 16 23.26	11 44 38.88
15	8 38 57.1	6	3179	—1 40.82	—10 54.32	10 16 22.27	11 40 49.97
15	8 41 56.3	5	3172	—1 12.71	+6 13.15	10 16 22.11	11 40 46.63
21	9 42 19.4	2	3174	—0 9.92	+18 1.51	10 17 30.12	10 59 20.47
25	8 28 30.9	14	3174	+0 4.69	+13 6.31	10 17 44.77	10 54 25.15
26	8 24 33.7	16	3174	+0 21.83	+7 52.48	10 18 1.94	10 49 11.19
27	8 32 20.5	9	3174	+0 40.79	+2 31.42	10 18 20.93	+10 43 50.00

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
(¹) Weisse, X. 399	8	^h 10 ^m 22 ^s 56.08	+12° 20' 48.66"	α from Weisse, δ mean of Weisse and Rümker.
Rümker, 3198	7	10 19 46.54	12 1 39.60	
3156	8	10 14 42.38	12 1 42.95	Rümker's Catalogue.
3179	7	10 18 0.53	11 51 55.47	
3172	8	10 17 32.25	11 34 44.72	
3174	8	10 17 37.64	+10 41 29.51	

(1) This star is Rümker, 3211. The α in Rümker is erroneous, being 3 seconds too large.

OCCULTATION OF VENUS. 1860, APRIL 24.

Apparent contact of the discs,	^h 8 ^m 30 ^s 19.98	Washington Mean Time.
First perceptible diminution of light,	8 31 54.82	" "
Disappearance of the planet,	8 32 59.15	" "
Reappearance (separation of the discs),	9 3 23.80	" "

At the instant of the apparent contact of the disc of the planet with the moon's dark limb, the sky was clear, but light clouds, not sufficient to obscure the planet or the moon, began to pass over them for a few seconds immediately after. Before the disappearance of the planet the sky had become again clear, so that this last phase was accurately observed. The planet was distinctly seen projected on the moon's dark surface, and, when it began to be eclipsed, the diminution of light was made by a circular line, inside the moon's limb and parallel to it. I had witnessed the same appearance at an occultation of *Venus*, 1855, April 19 (see *Astron. Journal*, IV.

96), and, expecting it again, had arranged the micrometer wires to measure the interval between the inner edge of the planet's disc and the dark limb of the moon at the instant when the light began to diminish, or when the planet had reached its greatest distance from the moon's edge. The passing clouds rendered this impossible, preventing a proper illumination of the wires. This occultation and that of 1855, April, present similar appearances, which I have not noticed to have been observed elsewhere. The barometer at the time of observation was 29.980, and the external thermometer, 49° Fahr. There was a high wind from northwest.

FIRST AND SECOND COMETS OF 1860.

A LETTER from Mr. LIAIS, Director of the Brazilian Coast Survey, to Prof. PETERS, published in the *Astronomische Nachrichten*, No. 1248, announces the discovery, February 26, at Olinda, Brazil, of a faint double comet, near the star μ *Doradus*. The larger portion preceded; it was brighter on the side toward the sun, and sensibly elongated in that direction, having near the extremity a small luminous point, about as bright as a star of the 9 magnitude. The object was so faint as to render observations difficult, for which reason the diameter could not be measured; but Mr. LIAIS estimated it at 25 or 30 seconds in

the larger, and 7 or 8 seconds in the smaller diameter. The second or smaller nebulousity appeared nearly circular, and about 4 seconds in diameter. On February 27, at 10^h 25^m, it followed the other by about 27 seconds, being about 1' 8" to the north of it.

On March 3, at 11^h 16^m, the difference of position was 23 seconds in right-ascension and 46" in declination. On the 6th, the moonlight completely extinguished the comet.

The following are the observations, made by Mr. LIAIS with the ring-micrometer.

Date.	Mean Time.			$\Delta \alpha$	$\Delta \delta$	Comparison-Star.	Mean Place, 1860.		
	^h	^m	^s	^m ^s	['] ^{''}		^h ^m ^s	[°] ['] ^{''}	
1860, Feb.	26	10	0	46.4	— 0 52.09	+ 1 38.1	μ Doradus	5 5 40.34	—61 59 59.3
	26	10	11	52.3	— 0 55.73	+ 1 59.3	"		
	26	10	24	13.3	— 0 59.68	+ 2 16.9	"		
	27	9	38	6.0	+34 42.54	+ 7 28.6	B. A. C. 1400	4 23 9.89	—61 33 18.6
	27	9	54	14.2	— 7 53.88	+34 0.1	μ Doradus		
	27	10	8	41.7	— 7 58.09	+34 18.6	"		
	29	11	42	20.8	+ 2 54.64	—19 45.6	B. A. C. 1189	4 42 13.12	—59 59 28.7
	29	11	57	25.7	+ 2 50.78	—19 21.1	"		
Mar.	3	9	21	10.9	—13 50.48	+31 43.4	B. A. C. 1503	4 44 55.94	—59 23 4.7
	3	9	46	0.1	—13 55.60	+32 19.4	"		
	3	10	7	7.4	—21 39.98	— 3 57.8	B. A. C. 1543	4 52 36.25	—58 46 20.9
	3	10	35	58.6	—21 44.20	— 3 22.2	"		

From these observations, Dr. PAPE of Altona has computed three normal places, and thence deduced elements as follows, — assuming the longitude of Olinda as $2^h 28^m 44^s$ W. from Paris :

Berlin M. T.	α	δ
1860, Feb. 26.55920	$76^\circ 11' 22.1''$	$-61^\circ 57' 43.1''$
29.62698	$71^\circ 15' 17.0''$	$-60^\circ 19' 14.5''$
Mar. 3.54898	$67^\circ 44' 47.4''$	$-58^\circ 50' 43.5''$

ELEMENTS.

$$\begin{aligned}
 T &= \text{Feb. 16.7667, Berlin M. T.} \\
 \pi &= 173^\circ 26.2' \\
 \varpi &= 324^\circ 1.9' \quad \left. \vphantom{\begin{matrix} \pi \\ \varpi \end{matrix}} \right\} \text{App. eq. Feb. 29.6.} \\
 i &= 79^\circ 22.6' \\
 \log q &= 0.07652
 \end{aligned}$$

Motion Direct.

The accordance with the middle observation is (C. — O.)
 $\Delta \cos \beta = +0.3$; $\Delta \beta = +0.3$.

A second comet was discovered at the Hamburg Observatory, April 17, by Mr. GEORGE RÜMKE. From the *Astronomische Nachrichten* I extract the following observations.

Place.	Date.	Mean Time of Place.	α	δ
Hamburg,	1860, April 17	$11^h 6^m 33^s$	$2^h 46^m 20.32^s$	$+48^\circ 28' 55.4''$
"	18	$10^h 1^m 10^s$	$2^h 50^m 49.96^s$	$48^\circ 56' 10.2''$
Altona,	18	$10^h 12^m 0^s$		$48^\circ 56' 5.6''$
"	21	$10^h 3.26^m$	$3^h 5^m 31.64^s$	$50^\circ 15' 24.8''$
Berlin,	22	$10^h 42^m 33^s$	$3^h 10^m 38.24^s$	$50^\circ 40' 52.6''$
"	23	$10^h 41^m 38^s$	$3^h 15^m 45.23^s$	$51^\circ 5' 6.8''$
"	24	$12^h 31^m 23^s$	$3^h 21^m 21.51^s$	$51^\circ 30' 32.6''$
Altona,	24	$9^h 36^m 48^s$	$3^h 20^m 46.54^s$	$51^\circ 27' 52.8''$
"	25	$9^h 34^m 41^s$	$3^h 26^m 0.53^s$	$51^\circ 50' 41.6''$
Berlin,	25	$13^h 15^m 51.6^s$	$3^h 26^m 52.73^s$	$+51^\circ 54' 9.0''$

The comet was so faint that on the 27th it could be no longer observed with the Altona equatorial.

From the observations at Hamburg April 17, Bonn April 20, and Berlin April 25, Dr. KRUEGER and Mr. TIELE, of Berlin, computed the following elements : —

$$\begin{aligned}
 T &= \text{Feb. 29.977, Berlin M. T.} \\
 \varpi &= 8^\circ 23' 19'' \\
 \pi &= 44^\circ 46' 37'' \quad \left. \vphantom{\begin{matrix} \varpi \\ \pi \end{matrix}} \right\} \text{App. eq. April 20.5.} \\
 i &= 48^\circ 8' 36'' \\
 \log q &= 0.10168 \\
 &\text{Motion Direct.}
 \end{aligned}$$

G.

MINIMA OF ALGOL VISIBLE AT WASHINGTON.

THE following ephemeris of *Algol*-minima has been obligingly communicated by Mr. TOOMER, in the hope that it may prompt to observations in various parts of the country.

Washington Mean Time.

1860, June 19	$15^h 36^m$	1860, Oct. 29	$12^h 51^m$	1861, Jan. 3	$11^h 37^m$	1861, July 14	$14^h 20^m$	1861, Oct. 28	$16^h 17^m$
July 12	$14^h 5^m$	Nov. 1	$9^h 40^m$	6	$8^h 26^m$	Aug. 3	$16^h 0^m$	31	$13^h 6^m$
Aug. 1	$15^h 45^m$	4	$6^h 28^m$	23	$13^h 21^m$	6	$12^h 48^m$	Nov. 3	$9^h 54^m$
4	$12^h 34^m$	15	$17^h 41^m$	26	$10^h 11^m$	26	$14^h 28^m$	6	$6^h 43^m$
24	$14^h 13^m$	18	$14^h 32^m$	29	$7^h 0^m$	29	$11^h 16^m$	17	$17^h 59^m$
27	$11^h 2^m$	21	$11^h 21^m$	Feb. 15	$11^h 55^m$	Sept. 1	$8^h 5^m$	20	$14^h 47^m$
Sept. 13	$15^h 53^m$	24	$8^h 10^m$	18	$8^h 45^m$	15	$16^h 7^m$	23	$11^h 36^m$
16	$12^h 41^m$	Dec. 8	$16^h 15^m$	Mar. 10	$10^h 29^m$	18	$12^h 56^m$	26	$8^h 25^m$
19	$9^h 30^m$	11	$13^h 4^m$	13	$7^h 18^m$	21	$9^h 45^m$	Dec. 10	$16^h 30^m$
Oct. 6	$14^h 21^m$	14	$9^h 53^m$	Apr. 2	$9^h 2^m$	Oct. 8	$14^h 36^m$	13	$13^h 19^m$
9	$11^h 10^m$	17	$6^h 42^m$	25	$7^h 35^m$	11	$11^h 25^m$	16	$10^h 8^m$
12	$7^h 59^m$	31	$14^h 48^m$	June 21	$15^h 51^m$	14	$8^h 13^m$	19	$6^h 57^m$
26	$16^h 2^m$								

FROM A LETTER OF PROFESSOR SAWITCH TO THE EDITOR.

St.-Petersburg, 1860, May 9.

Let me also communicate herewith some of my observations : —

The only occultation of the *Pleiades* by the moon which the weather has rendered it possible for us to observe in St.-Petersburg are the following, which I hope may be found useful for your Coast Survey.

Date.	Star.	St.-Petersburg	Sidereal Time.	Observer.
1858, December 18	27 <i>f</i> <i>Pleiadum</i> (<i>Atlas</i>),	Emersion at	21 ^h 0 ^m 6.3 ^s	S.
			0 4.3	O.
	28 <i>h</i> “ (<i>Pleione</i>),	“	21 8 36.8	S.
			8 35.2	O.
Both of these are about 5* too late.				
1859, January 14	19 <i>e</i> <i>Pleiadum</i> (<i>Taygeta</i>),	Immersion at	8 40 2.6	O.
			40 1.8	R.
	22 <i>l</i> “ “	“	9 0 36.8	O.
			0 36.1	R.
1859, April 6	16 <i>g</i> “ (<i>Celæna</i>),	“	9 2 4.2	S.
			2 3.4	O.
			2 3.7	St.
	19 <i>e</i> “ (<i>Taygeta</i>),	“	9 9 26.4	S.
			9 26.3	O.
			9 26.2	St.
	20 <i>c</i> “ (<i>Maia</i>),	“	9 25 29.8	S.
			25 29.6	O.
			25 30.2	St.
	21 <i>k</i> “ (<i>Asterope</i>),	“	9 28 41.6	O.

In the column "Observer," S. stands for SAWITCH; O. for Captain OBLANIEWKY; R. for Lieut.-Colonel RICHNEWSKY; St. for Captain STIBNITZKY.

I have also observed the occultation of *Saturn* by the Moon on the 8th May, 1859, but this observation is not very satisfactory.

At Immersion.

	St.-Petersburg Sidereal Time.
First contact of the ring, at	13 ^h 20 ^m 30.0 ^s
Contact of the planet's I Limb,	20 36.0
Contact of the planet's II Limb,	21 18.0
Last contact of the ring,	13 21 31.5

At Emersion.

Last contact of the ring,	14 5 22.0
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The following are observations of the planet *Neptune* at opposition and quadrature; the right-ascensions and declinations being for the moment of transit across the meridian of St.-Petersburg, and corrected for refraction.

Date.		Apparent α	Apparent δ
1858, Sept.	2	23 ^h 39 ^m 32.91 ^s	—3° 35' 22.0"
	3	39 27.13	35 54.1
	4	39 21.57	36 38.0
	5	39 15.42	37 17.6
	11	38 39.32	41 13.9
	12	38 33.48	41 55.1
	16	38 9.02	44 32.3
	17	23 38 3.00	—3 45 13.1
1858, Nov.	26	23 33 6.10	—4 15 56.2
1859, Sept.	4	23 48 54.74	—2 44 55.1
	10	47 19.05	—2 48 45.2

The comparison-stars in 1858 were 96 *Aquarii* and 11 *Piscium*; in 1859, γ *Piscium* and 12 *Ceti*; their places being taken from the British Association Catalogue.

A. SAWITCH.

ON BIELA'S COMET.

By PROFESSOR J. S. HUBBARD.

OF THE WASHINGTON OBSERVATORY.

I.

THE interesting comet known since 1826 as BIELA'S was first discovered on the 8th of March, 1772, by MONTAIGNE, at Limoges. The few and partially imperfect observations obtained at this time were, without difficulty, represented by the parabolas of LALANDE⁽¹⁾ and BURCKHARDT.⁽²⁾ But in 1805 the orbits computed for the comet 1806 I, discovered by PONS on the 10th of November, were found to bear so striking a resemblance with these just mentioned, that the question of identity was immediately raised, and the attempt made to ascertain the true dimensions of the orbit. BESSEL,⁽³⁾ assuming a single revolution between 1772 and 1806, computed, with the corresponding major axis, an ellipse which represented the observations at each appearance equally well with his best parabolas; and GAUSS,⁽⁴⁾ proceeding independently of hypothesis respecting the period, found that the observations in 1805 were best represented by an ellipse of 4.7 years, and then, with the perihelion and aphelion distance corresponding to the ellipse, computed another orbit to satisfy the places observed in 1772. The differences, however, between these orbits were yet so great as to render him doubtful respecting an identity which only seemed probable in case the comet had remained for a long time in near proximity to a large disturbing planet, a condition that was not fulfilled by BESSEL'S ellipse.

Thus the matter rested until 1826, when the first orbits obtained for the comet, discovered by BIELA on the 27th of February, revealed the true period, and fixed the position of the comet as a citizen in the solar system. BIELA announced the identity established by his computed elements in a letter to SCHUMACHER,⁽⁵⁾ dated March 23, and subsequently stated⁽⁶⁾ that he had arrived at this result, and sent the same announcement to Prague, on the 15th of that month. GAMBART discovered the comet independently on the 10th of March, and on the 22d sent to SCHUMACHER⁽⁷⁾ his elements, with the expression of his conviction that the comet was the same with that of 1772 and 1806. Afterwards, assuming the corresponding mean motion, he computed elliptic elements for 1806 and for 1826.⁽⁸⁾ CLAUSEN also, without knowing the above facts, arrived at the same conclusions,⁽⁹⁾ and then, computing without hypothesis, obtained first, misled by an erroneously given position, an orbit of very short period, which failed to follow the comet, and afterwards a well-working ellipse, with

a period of 2138 days, giving five revolutions between 1772 and 1806, and three between 1806 and 1826, and fulfilling, moreover, the condition of unusually great perturbations during the former interval, bringing the comet, in fact, twice very close to *Jupiter*, first in 1782, and again in 1794. He subsequently computed also, from all the observations known to him, a third still more accurate set of elements,⁽¹⁰⁾ in which the periodic time is 2460.33 days.

No sooner were the nature and dimensions of the comet's true path ascertained, than OLBERS, with characteristic sagacity, discovered and called attention⁽¹¹⁾ to the remarkably close approximation of its orbit at the descending node to that of the earth. At this place the minimum distance of the two orbits is so small, that the variations produced by the disturbing action of the planets may well cause it to vanish entirely; and thus it is within the limits of possibility, that in the course of revolutions, the perihelion-passage happening at the right day and hour in December, the two bodies may be brought into collision. It afterwards appeared that the closeness of approach was much more remarkable in 1832 than in 1826,⁽¹²⁾ and OLBERS gives the following minimum orbit-distances for the three returns for which elliptic elements had been computed, viz.:—

In 1806,	$\Delta = 0.0086267$;
1826,	$\Delta = 0.0060383$;
1832,	$\Delta = 0.0001950$.

At the first two of these dates the comet-orbit was outside that of the earth at this point, at the last date it was within it. Although, with the average period, since 1772, of 2453 days, the perihelion-passage will not happen in December for more than a century, yet the perturbations which the comet will experience may occasion an earlier fulfilment of this condition, while the possibility of so close a coincidence of the two bodies gives an especial interest to all general calculations respecting the motions of the comet.

Shortly after the appearance in 1826, DAMOISEAU undertook the computation of the variations of mean daily motion and mean anomaly caused by the disturbing influence of the Earth, *Jupiter*, and *Saturn* during the long interval from 1806 to 1826, and found⁽¹³⁾

$$\delta u = +1''.5991, \text{ and } \delta M = +1^\circ 5' 4''.71;$$

from which he inferred that if we assume for the period of the comet the mean value 2460.1627 days, as would result from

⁽¹⁾ *Astronomie*, III.⁽²⁾ *Conn. d. Temps*, 1811, 486.⁽³⁾ *Briefwechsel zw. OLBERS und BESSEL*, I. 27.⁽⁴⁾ *Monatl. Corr.*, XIV. 79, 84. ⁽⁵⁾ *Astr. Nachr.*, IV. 470.⁽⁶⁾ *Astr. Nachr.*, IV. 506. ⁽⁷⁾ *Astr. Nachr.*, IV. 470.⁽⁸⁾ *Mem. R. Ast. Soc.*, II. 505. ⁽⁹⁾ *Astr. Nachr.*, IV. 466.⁽¹⁰⁾ HARDING and WIESEN, *Kl. Astr. Ephem.*, 1832, 97.⁽¹¹⁾ *Astr. Nachr.*, IV. 501.⁽¹²⁾ *Astr. Nachr.*, VI. 159.⁽¹³⁾ *Conn. d. Temps*, 1830, 52.

the observed times of perihelion-passage, the value to be adopted in the calculation of observations in 1826 is 2455.1762 days. He next computed the perturbations of all the elements from 1826 to 1832, and found, assuming GAMBART's ellipse for the former year, that the next return to perihelion would take place 1832, November 26.9743 (Greenwich Time), and that the mean daily motion at this date would be 533".4409. His memoir is accompanied by an ephemeris, which OLBERS declares⁽¹⁾ to be as full of error as the perturbations are of truth, substituting correct values, based upon CLAUSEN's third elements, which he brought forward by DAMOISEAU's perturbations.

Before the return in 1832, SANTINI, having also noticed the above-mentioned errors, was induced to recompute, not only the ephemeris itself, but also the perturbations upon which it was based, and thus was commenced that long and highly interesting series of investigations which he has continued to the present time, and which have so materially facilitated the rediscovery of the comet at its subsequent returns to visibility. He had previously determined,⁽²⁾ by the method of least squares, the elements which best represented four of his own observations, upon the assumption of the average period from 1826. Now substituting DAMOISEAU's instantaneous value of this element, he computed with great care and thoroughness the perturbations caused by all the older planets, from *Venus* to *Saturn* inclusive, and found results⁽³⁾ agreeing generally with those of the French astronomer, and in which the predicted time of perihelion-passage was November 26.3740.

In the mean time the comet had returned to perihelion and was observed from September 23 to January 3, and we have from various sources several independent computations of the elements for this epoch. BARANOWSKI⁽⁴⁾ obtained a very accurate orbit, based upon and perfectly representing the splendid series of observations by the masters BESSEL and STRUVE; BURG⁽⁵⁾ computed elements from a large number of observations, including the earliest and latest, and SANTINI⁽⁶⁾ deduced an orbit from his own observations, combined with HERSCHEL's in September, and two others by BESSEL and NICOLAI in October. From these results it appeared that the actual perihelion-passage took place November 26.12, or several hours before even the earliest predicted time, a circumstance which ENCKE⁽⁷⁾ was disposed to refer to the same cause which had accelerated the motions of the comet which bears his name, while SANTINI found⁽⁸⁾ on trial that ENCKE's formulas and constant gave an acceleration in this case of only 0'.03, and referred, with more plausibility, to the uncertainty of the mean motion assumed for 1826. He then, adopting his own values of the perturbations, and comparing

his observed times of perihelion-passage, made a new determination of the semi-axis major and of the corresponding values of his elements in 1826 and 1832.⁽⁹⁾

Upon the basis thus obtained, he proceeded to compute the perturbations during the following revolution, and found⁽¹⁰⁾ that the perihelion-passage in 1839 would take place on the 23d of July, at which season, from the position of the orbit, it is always difficult, and generally impossible, to observe the comet; in fact, it escaped detection entirely at this return.

Undiscouraged, SANTINI followed the comet through another revolution,⁽¹¹⁾ and predicted its return to perihelion in 1846, February 11.368; the effect of perturbation upon this element since 1839 being no less than 31.88 days. The comet, when first refound at Berlin,⁽¹²⁾ after an absence of 13 years, was only 6' distant in right-ascension, and less than 1' in declination, from the place indicated by SANTINI; a wonderful confirmation of the accuracy of these long and difficult computations, and a result which must have afforded peculiar gratification to the distinguished astronomer whose skill and perseverance were thus so well rewarded.

As the comet approached the earth, the deviation of the ephemeris increased, and BRÜNNOW and D'ARREST computed, from observations of November 29, December 26, and January 27, a new set of elements,⁽¹³⁾ which, from the well-chosen intervals of time and the known skill of the computers, possess great claim to accuracy. PLANTAMOUR also⁽¹⁴⁾ obtained for each nucleus — the comet being now double — an orbit, based upon the whole series of his own observations at Geneva. More recently, I have given⁽¹⁵⁾ the results of an attempt to determine elements for the nuclei from all the observations that could be collected. The time of perihelion-passage thus deduced from observation was again earlier than predicted, but only by 0'.375; and it yet remains to be ascertained whether this small difference is due to a possible slight correction of the assumed mean motion, or to the effect of terms of the second order in the perturbations, — the elements having been retained unchanged during each whole revolution, — or to some other cause.

Before the next return, in September, 1852, SANTINI was again in the field with elements and ephemeris.⁽¹⁶⁾ Unfortunately he had now abandoned his own correct value of the mean motion, and assumed another, which proved less trustworthy, so that some observers, trusting too closely to the ephemeris, failed to find the comet, while others met with less success than the circumstances would otherwise have afforded. From the few observations of the following nucleus, obtained between August 25 and September 25, and of the preceding nucleus

(¹) *Kl. Astr. Eph.*, 1832, 98.

(²) *Nuovi Saggi dell' I. R. Accad. di Padova*, III. 328.

(³) *Astr. Nachr.*, XI. 196.

(⁴) *Astr. Nachr.*, XIII. 245, XIV. 177.

(⁵) *Annalen der k. k. Sternwarte in Wien*, XIV. xxxvii.

(⁶) *Opuscoli Astron.*, 36.

(⁷) *Astr. Nachr.*, XI. 196.

(⁸) *Astr. Nachr.*, XII. 113.

(⁹) *Opuscoli*, 43; *Astr. Nachr.*, XII. 115.

(¹⁰) *Astr. Nachr.*, XII. 117; *Opuscoli*.

(¹¹) *Nuovi Saggi*, VI. 367.

(¹²) *Astr. Nachr.*, XXIII. 382.

(¹³) *Astr. Nachr.*, XXIV. 19.

(¹⁴) *Astr. Nachr.*, XXV. 125.

(¹⁵) *Astr. Journal*, N^{os}. 56, et seqq.

(¹⁶) *Mem. dell' I. R. Istituto Veneto*, V. 1.

between the 15th and 25th of September, D'ARREST⁽¹⁾ succeeded in computing elements for each, according to which the perihelion-passage of the one occurred September 22.94, and of the other September 23.71, while the application of SANTINI's values of the perturbations and mean motion to the correct elements for 1846 gave the predicted time September 22.30,⁽²⁾ indicating a retardation whose true amount is, however, from the circumstances, subject to great uncertainty.

The last return to the perihelion took place in May, 1859,

⁽¹⁾ *Astr. Nachr.*, XXXIX. 321, et seqq.

⁽²⁾ *Cometa di BIELA nel 1859*, 10.

at which epoch the comet was so completely lost in the sun's light, that even the most powerful telescopes failed to detect it, though guided by an ephemeris which, if we may judge from the agreement of three independent computers,⁽³⁾ must have been not far from the truth.

May the illustrious astronomer of Padua yet live to witness many returns of this comet, which he has followed with so much ability and success for more than thirty years, and with whose history his own name is so intimately associated.

⁽³⁾ *Cometa di BIELA nel 1839*, t5; *Bulletin de l'Acad. de St.-Petersbourg*, XVI.; *Astr. Journal*, V. 186.

(To be continued.)

NEW WORK.

Astronomische Beobachtungen auf der Sternwarte zu Bonn, angestellt und herausgegeben von Dr. FR. W. A. ARGELANDER. Dritter Band. Bonner Sternverzeichniss, I. Section.

(Continued from page 104.)

The degree of completeness of the Catalogue may be inferred from the following investigation by Professor ARGELANDER. Comparing it with about 26,000 stars from the zones of LALANDE and BESSEL, and correcting some obvious errors on both sides, which were thus detected,—a list of all the remaining discordances was prepared. These were investigated by Professor ARGELANDER with the meridian-circle, who found that the chief portion of those stars which actually existed, though not recorded in the Bonn Catalogue, were extremely near to brighter ones, so that the separation of the two was difficult or impossible for the telescope and power employed. Deducting these cases, only 23 stars remained, which were recorded by BESSEL and LALANDE, though wanting in the *Durchmusterung*. Of these 23, there are 7 not now visible in the recorded place, and one of them, indeed, has been shown by Mr. POWALKY to have been the planet *Amphitrite*, observed by BESSEL as a fixed star; 4 have been discovered to

be variable, 1 is proved to have been due to an error of observation, 4 more, of the 9.10 magnitude, were near to brighter stars, and out of the 26,000, only 7 are found to have been omitted without palpable reason! Other tests accord in indicating the same degree of completeness.

A careful comparison of the magnitudes shows that Professor ARGELANDER's estimates of stars make them somewhat brighter than BESSEL's, and fainter than LALANDE's,—the range of a unit of magnitude being for ARGELANDER's determination about nine tenths of the corresponding range for BESSEL's. The average magnitude of 347 stars given in the Pulkowa Catalogue as 7^M, is in the Bonn Catalogue 7^M.673.

Professor ARGELANDER and his co-laborers have shown what may be done at a single observatory, with few instruments, by devotion and zeal, and have added yet another to the many previous claims of the illustrious author upon the gratitude and admiration of astronomers now living, and of those who will live hereafter. May they long be spared to receive and enjoy the tokens of this gratitude, and the reward of their devotion and toil.

Cambridge, 1860, April 26.

G.

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FIRST AND SECOND COMETS OF 1860.

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FROM A LETTER OF PROFESSOR SAWITCH TO THE EDITOR.

ON BIELA'S COMET, BY PROFESSOR J. S. HUBBARD.

NEW WORK.

THE ASTRONOMICAL JOURNAL.

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NO. 15.

ON BIELA'S COMET.

By PROFESSOR J. S. HUBBARD

OF THE WASHINGTON OBSERVATORY.

II.

§ 1. FIRST APPEARANCE, 1772.

THE first discovery of this comet was made, as mentioned above, by MONTAIGNE, at Limoges, on the 8th of March, 1772. It was quite faint, being invisible to the naked eye, it had a nucleus of moderate brilliancy, and a tail of 4' or 5' in length, and the whole appeared no brighter in the telescope than a star of the sixth magnitude.

Owing to the want of proper instruments, the discoverer was unable to determine accurately the comet's position. His observations of the 8th and 9th are given in a communication from MESSIER to the French Academy, and are as follows:—

	App. T. Limoges.	Greenwich M. T.	α	δ
1772, March 8	^h 8 ^m 30	^d .3580	65° 17' 49"	—3° 40' 17"
9	7 30	.3161	66 39 19	—3 37 17

These declinations involve the inconsistency of a northward motion, when, in fact, as will be seen presently, the comet was moving southward at the time.

In the *Connaissance des Temps* for 1811 is a short memoir by BURCKHARDT on the orbit of this comet, in which that eminent astronomer states that he has found among the papers of

“Le 8 Mars,—à 7 heures 30 minutes, la comète étoit moins avancée que l'étoile (*r Eridani*) d'un degré en ascension droite et sa déclinaison australe étoit moindre de 10 minutes que celle de l'étoile. À 9^h 30', la comète s'étoit approchée de 7 minutes de l'étoile, et n'avoit presque point changée de déclinaison.

Le 9 Mars, à 7^h 30' du soir, la comète étoit plus avancée que l'étoile *r* de 25 minutes en ascension droite, et sa déclinaison australe étoit diminuée de 3 minutes.”⁽¹⁾

From these notes I have deduced the following places:—

LEMONNIER, the originals of MONTAIGNE's observations, consisting of configurations of the comet with telescopic stars on the 8th and 14th, and of observed differences of right-ascension and declination, to minutes only, on the 20th of March, and gives the following as the result of his own reductions⁽²⁾:—

	Apparent T. Limoges.	α	δ
1772, March 8	^h 9 ^m 30	65° 52' "	—3° 27' "
14	8 14	73 36	—4 42
20	7 53	81 48 55	—6 7 23

The first of these positions is inconsistent with that given above for the same date, and which rests upon more reliable data; the second, being of the same nature with the first, is consequently rendered doubtful. I have retained it only for comparison.

As soon as MONTAIGNE's discovery was known at Paris, MESSIER instituted a diligent search for the comet, but so faint had it now become, that even his practised eye failed to detect

it, and it was only after long-continued search, and when nearly despairing, that at length, on the 26th of March, he succeeded in finding the comet, and for that date, the 27th and 30th, and the 3d of April, he has given the differences from neighboring stars, as determined by the filar micrometer. These observations are as follows⁽³⁾:—

⁽¹⁾ *Mém. de l'Acad.*, 1777, 345.

⁽²⁾ *Conn. d. Temps*, 1811, 486.

⁽³⁾ *Mém. de l'Acad.*, 1777, 345.

1772.	Temps vraie.	Difference en Ascension-droite entre la Comète et les Étoiles.	Difference de Declinaison entre la Comète et les Étoiles.	Grandeur des Étoiles.	Étoiles avec lesquelles la Comète a été comparée.
	^h ^m ^s				
Mars 26	8 25 33	—0° 44' 30"	—0° 52' 50"	5	5 de la Licorne Fl.
27	8 16 42	+0 38 15	—1 0 56	5	5 " "
30	8 39 59	+3 32 30	+0 2 42	6	7 " "
30	8 39 59	+1 16 45	—0 49 25	4	11 " "
Avril 3	8 57 21	—0 22 0	—0 19 17	9	(Lalande, 13464.)

Although, from the extreme faintness of the comet at this time, no great degree of accuracy is to be expected from these observations, I have yet thought them worthy of a rigorous

reduction, which, being accomplished, leads to the results in the subjoined table.

Date.	Comparison-Star.		Greenwich M. T.	Comet's	
	Apparent α	Apparent δ		α	δ
1772, March 26	90° 56' 19.2	—6° 13' 34.0	.34463	90° 11' 53.0	—7° 6' 17.8
27	18.9	33.9	.33825	91 34 37.4	7 14 24.1
30	92 11 15.4	7 44 58.0	.35368	95 43 51.4	7 42 5.4
30	94 26 47.9	6 54 40.3	.35368	43 36.4	43 59.7
April 3	101 30 43.6	—7 54 2.5	.36475	101 8 48.5	—8 13 11.6

I am not aware that any other observations were made at this appearance of the comet.

§ 2.

Besides the parabolic orbits based upon some of the observations quoted above, we have the two sets of elliptic elements mentioned in the preceding memoir: one obtained by BESSEL⁽¹⁾ upon the assumption of a periodic time corresponding to a single revolution of the comet between 1772 and 1806, and the other computed by GAUSS⁽²⁾ to satisfy the semi-axis major and eccentricity deduced by him, independently of hypothesis, from the observations in 1805, and which correspond to a period of between four and five years. Interpolating roughly between these ellipses, I obtained an orbit whose semi-axis major was nearly of the true value, and which represented MESSIER's right-ascensions within 1' and his declinations within

5'.5, but departed much more widely from the earlier observed places. The second approximation from this assumed orbit led to the following residuals:—

	$\Delta\alpha$	$\Delta\delta$		$\Delta\alpha$	$\Delta\delta$
Mar. 8	+177"	+373"	Mar. 26	+15.2	+9.4
9	—57	—575	27	—1.3	—60.7
14	—291	—609	30	—25.1	+80.2
20	+59	+224	Apr 3	+8.8	+55.6

I now found it impossible to represent MESSIER's declinations more closely by assigning any relative weight whatever to those of MONTAIGNE, and finally omitted the latter entirely, as well as the whole configuration-observation of March 14, and then, giving the weight one-half to each of MONTAIGNE's remaining right-ascensions, arrived finally at the following results:—

ELEMENTS, 1772.

Greenwich M. T. Mean Equinox 1772.0.

M, Feb. 17.0	0° 3' 0.62 +	2.924 $\Delta\mu$	T Feb. 16.65531
Ω_0	318 20 7.76 +	27.425 $\Delta\mu$	Ω 257° 15' 38.45
ω_0	148 31 6.60 —	27.656 $\Delta\mu$	ω 213 2 56.72
i_0	25 29 2.97 +	2.405 $\Delta\mu$	i 17 3 7.88
q	46 25 40.89 —	100.324 $\Delta\mu$	
Assumed μ	524.0 +	$\Delta\mu$	

RESIDUALS.

MONTAIGNE.			MESSIER.		
Date.	$\Delta\alpha$	$\Delta\delta$	Date.	$\Delta\alpha$	$\Delta\delta$
March 8	+102"	+611"	March 26	+10.7	+25.3
9	—126	—349	27	—5.0	—56.4
11	—332	—414	30	—25.4	+50.4
20	+39	+313	April 3	+13.8	—18.9

(¹) *Monatl. Corr.*, XIV. 74.

(²) *Monatl. Corr.*, XIV. 84.

NORMAL OBSERVATION.

		O. — C.					
		$\Delta\alpha$	$\Delta\delta$	α	δ	No. of Obs.	
I.	1772, March 30.0	+1".5	—0".1	95° 14' 18".6	—7° 39' 12".7	4	4

In the final elimination, the value of $\Delta\mu$ was absolutely sensible, or, in other words, that almost any value may be indeterminate, its coefficient vanishing entirely, whence it assumed for $\Delta\mu$ without sensibly affecting the representation follows that the coefficients $\Delta\mu\alpha$ and $\Delta\mu\delta$ are practically in- of the observations.

§ 3. SECOND APPEARANCE, 1805.

The second observed return of this comet to the perihelion was characterized by a very close approach to the earth, the least distance being only 0.03. Unfortunately for the determination of the orbit, the comet's rapid southward motion carried it below the European horizon just at the time of greatest brilliancy, putting an abrupt stop to the observations which, had they been continued in the southern hemisphere for a few days longer, would have led at once to a definite knowledge of the dimensions of the orbit, and secured recognition of the comet in 1812, if not in 1819. It is not easy to imagine what would have been the resulting progress in the theory of this remarkable body.

The comet was discovered on the 10th of November, in the constellation *Andromeda*, by PONS, at Marseilles. During the whole time of its visibility it appeared round, entirely tailless, and with a pretty well defined planetary nucleus, from which the light diminished uniformly on every side, and which always presented an excellent mark for the observer. At the time of nearest approach to the earth, December 8 and 9, the comet was a conspicuous object to the naked eye, even in presence of the moon, then two days past the full. The last observation was made on the 9th, by THULIS, at Marseilles, the comet being then below 35° S. declination.

On the 8th of December, some interesting physical observations of the comet were made by SCHRÖTER, at Lilienthal, with a 13-foot reflecting telescope.⁽¹⁾ He found the apparent diameter of the central brightest portion of the nucleus to be 4".052, and that of the whole nucleus, as distinct from the coma, 6".419; the diameter of the whole comet as far as visible in his telescope, was 330". As the distance of the comet from the earth was at this time, according to the ele-

ments given below, only 0.0379, we hence infer the following true dimensions:—

Diameter of whole comet	=	5770	statute miles.
" " nucleus	=	112.2	"
" central brightest part	=	70.8	"

§ 4.

The observations at this epoch extend only from Nov. 10 to Dec. 9. They are 39 in number, of which the greater part were made at Marseilles and Paris, and of these the originals are given in a completely reducible state: the corrections of the rest, on account of refractions, &c., are doubtless negligible by side of the observation-errors. I commenced the reductions with the elements computed by GAMBART,⁽²⁾ upon the assumption of a periodic time inferred from comparison of the perihelion-passages in 1806 and 1826. It appeared, however, upon trial, that at the perigee this orbit departed too widely from the comet's true place to be used with safety:—this was due partly to the difference between the old and new solar tables, but mainly to small element-errors magnified in the geocentric places by the factor $\frac{1}{2}$.

After two or three approximations, I obtained the following more correct elements, in which GAMBART's value of μ is retained.

PROVISIONAL ELEMENTS.

Greenwich M. T. Mean Equinox 1806.0.

M, Jan. 2.0	0° 0' 42".82
Ω_0	324 57 1.54
ω_0	141 51 26.36
i_0	22 50 2.44
φ	48 13 12.39
μ	526.6751

§ 5. OBSERVATIONS.

Berlin. *Berliner Astron. Jahrb.* 1809, 263.

Date.	Greenwich M. T.	α	δ	$\Delta\alpha$	$\Delta\delta$
1805, Nov.	28.41709	7° 58' 59".5	+28° 23' 35".4	+8".6	+14".8

Bremen. (OLBERS.) *Briefwechsel zwischen OLBERS und BESSEL*, I. 20.

Date.	Greenwich M. T.	α	δ	$\Delta\alpha$	$\Delta\delta$
1805, Dec.	2.20716	4° 46' 29".2	+19° 0' 21".2	+4".1	—48".4
	3.21726	3 38 20.9	+15 8 19.7	—21.4	—107.0
	8.25192	353 11 5.7	—23 24 43.7	(—84.3)	(—176.7)

⁽¹⁾ *Berliner Ast. Jahrb.*, 1809, 140.

⁽²⁾ *Astr. Nachr.*, V. 126.

Brunswick. (GAUSS.) *Mon. Corr.*, XIII. 89.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1805, Dec.	8.25892	353° 8' 0.3	—23° 32' 46.1	+11.0	+11.7
	.30251	352 58 57.8		—14.9	

Greenwich. (MASKELYNE.) *Berliner Astron. Jahrb.*, 1809, 280.

Date.	Greenwich M. T.	α	δ	C. — O.		Remark.
				$\Delta\alpha$	$\Delta\delta$	
1805, Dec.	8.26653	353° 6' 54.0	—23° 37' 36.7	—21.2	—17.8	Meridian observation.

Marseilles. (THULIS.) *Mon. Corr.*, XIII. 195.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1805, Nov.	11.28021	16° 13' 5.4	+40° 33' 46.5	+101.2	(—249.0)
	.61819	6 26.9	25 3.4	+ 28.8	— 3.7
	15.42016	11 35 47.6	39 18 13.1	— 26.1	— 0.1
	16.28804	14 13 50.4	38 58 7.5	— 17.7	+ 25.2
	19.28360	12 55 0.4	37 33 25.7	+ 9.3	+ 55.2
	20.27806	12 28 28.9	37 0 19.0	— 35.1	— 38.0
	21.38420	11 56 25.9	36 16 39.2	+ 14.2	— 21.6
	22.40491	11 27 4.6	35 31 8.2	— 12.5	— 5.1
	23.29556	10 59 53.2	34 46 14.4	+ 4.2	+ 37.2
	29.26214	7 22 54.8	26 48 9.1	— 22.3	+ 2.4
Dec.	2.38676	4 35 3.4	18 21 24.8	+ 1.9	+ 9.9
	3.25598	3 35 9.0	14 56 35.9	— 0.2	— 0.2
	4.25634	2 15 14.9	+10 8 29.4	— 3.4	— 7.5
	6.28778	358 39 17.4	— 3 36 31.6	— 10.7	+ 0.8
	7.30106	356 9 57.9	13 1 27.6	— 11.2	— 15.1
	8.27628	353 4 26.0	—23 44 43.9	— 0.4	0.0

Meridian. *Mon. Corr.*, XIV. 382, 383.

Date.	Greenwich M. T.	α	C. — O. $\Delta\alpha$	Date.	Greenwich M. T.	α	C. — O. $\Delta\alpha$
1805, Nov.	10.39193	16° 53' 53.7	+ 77.3	1805, Nov.	23.34160	10° 58' 52.1	— 19.9
	11.38825	16 12 18.9	— 2.5	Dec.	6.27260	358 41 37.8	— 31.8
	15.37319	14 38 17.1	—105.4		7.26318	356 16 18.5	— 15.2
	16.36938	14 13 51.8	—142.9		8.25186	353 9 54.0	— 11.8
	21.34964	11 56 44.1	+ 55.4		9.23774	349 3 3.9	— 24.6
	22.34566	11 28 41.6	— 4.1				

Paris. (BOUVARD.) *Conn. des Temps*, 1809, 326, 327.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1805, Nov.	16.44123	14° 10' 5.7	+38° 55' 36.2	— 26.4	— 43.8
	.45307	10 8.2	55 2.7	— 47.1	— 27.4
	17.31562	13 47 22.0	38 32 26.2	— 8.6	+ 16.1
	.32259	46 38.5	32 21.0	+ 24.0	+ 10.6
	.35203	45 46.2		+ 30.6	
	.39155	45 10.2	31 33.2	+ 5.2	(—232.4)
	18.35676	13 19 10.4	38 3 32.4	+ 47.9	— 8.3
	.42672	17 35.3	0 58.6	+ 31.8	+ 20.0
	23.28049	11 1 25.4	34 47 11.9	— 60.3	+ 23.9
	.30244	0 31.9	46 1.8	— 47.4	+ 28.0
	.32777	10 58 24.5	44 57.0	+ 33.3	+ 13.2

Date.	Greenwich M. T.	α	δ	$\Delta\alpha$	$\Delta\delta$
C. — O.					
1805, Nov.	.30.48940	6° 22' 24.2	0 1 15.1	+ 83.8	"
	.48940	21 54.6	+24 1 15.1	+113.4	+ 94.3
	.50397	21 42.3		+ 81.2	
	.50397	21 27.7	23 59 9.5	+ 95.8	+ 88.7
Dec.	5.26079	0 39 47.0	4 7 14.6	— 29.7	— 21.9
	.33671	30 55.4		+ 20.2	
<i>Meridian.</i>					
Dec.	5.28902	0 36 36.0	+ 3 55 15.3	— 16.9	+ 14.2

Combining the above residuals by giving the same weight to each day's work of each observer, I obtained the following normal residuals and places, which may be considered as fully representing the observations at this epoch.

		O. — C.				No. of Observations.	
Greenwich M. T.		$\Delta\alpha$	$\Delta\delta$	α	δ	α	δ
II.	1805, Nov. 18.0	+ 7.9	— 4.5	13° 29' 30.6	+38° 13' 44.7	19	12
III.	Dec. 2.0	— 5.6	+5.6	4 59 21.1	+19 41 46.3	8	8
IV.	6.0	+15.1	+5.5	359 15 44.6	— 1 15 56.3	6	4
V.	8.25	+ 8.8	+3.0	353 10 15.3	—23 26 17.0	4	8

§ 6.

An attempt to obtain a somewhat closer representation of these normals led to the following results, which may be con-

sidered as definitive. The elimination showed, as in the first appearance, that the observations themselves were powerless to furnish a determination of μ within any reasonable limits.

ELEMENTS, 1806.

Greenwich M. T. Mean Equinox 1806.0.

M , Jan. 2.0	0° 0' 43.47 —	1.526 $\Delta\mu$	T Jan. 1.917463
Ω_0	324 57 9.32 +	37.647 $\Delta\mu$	Ω 251° 16' 19.03
ω_0	141 51 12.26 —	31.305 $\Delta\mu$	ω 218 12 6.19
i_0	22 50 2.02 —	2.752 $\Delta\mu$	i 13 36 34.37
q	48 13 11.45 —	101.208 $\Delta\mu$	
Assumed μ	526.6751 +	$\Delta\mu$	

RESIDUALS.

	$\Delta\alpha$	$\Delta\delta$
November 18	— 9.3	+1.9
December 2	+12.1	—3.1
6	— 7.4	—0.1
8.25	+ 1.9	—0.3

§ 7. THIRD APPEARANCE, 1826.

It was at this appearance of our comet that its true period was first clearly ascertained. BIELA found the comet on the 27th of February, and GAMBART discovered it independently on the 10th of March. The early announcement of its undoubted identity with the comets of 1772 and 1806, l. stimulated observers everywhere, and although it was always

faint, — its least distance from the earth being 0.96, — and during the time of full moon, late in March and in April, was entirely invisible for several days, yet quite a large number of satisfactory determinations of its place were obtained. The latest observation was made by BRIOSCHI, at Naples, on the 10th of May.

The reduction and comparison of observations were performed by the help of SANTINI'S elements,⁽¹⁾ which are as follows:—

ELEMENTS.

Greenwich M. T. Mean Equinox 1826.0.

M. March 18.0	359 56' 22.39"		
Ω_0	325 5 28.38	Ω	251° 28' 20.00
ω_0	142 0 36.92	ω	218 17 27.84
i_0	22 52 0.28 "	i	13 33 51.09
φ	48 17 39.70		
μ	527.960		

§ 8. OBSERVATIONS.

Åbo. (ARGELANDER.) Ring-Micrometer. *Astr. Nachr.*, IV. 535.

Date.	Greenwich M. T.	α	δ	C. — O.		Correction of assumed star-places.	
				$\Delta\alpha$	$\Delta\delta$	$d\alpha$	$d\delta$
1826, Apr.	3.34969	68° 50' 43.2"		+42.9		+ 9.2	
	.35188		+10° 39' 31.7"		+ 7.3		—0.5
	4.33392		10 36 11.3		+16.3		+1.5
	.33415	70 11 9.0		+47.9		—10.9	
	5.31975	71 32 15.2	10 32 38.9	+42.8	+14.5	+ 5.5	+2.1
	6.33636	72 56 15.0	10 28 34.0	+41.6	+15.2	+ 5.5	+2.1
	9.31937	77 4 52.7	10 14 1.6	+36.5	+33.5	+ 1.2	+0.7

Altona. (CLAUSEN.) Ring-Micrometer. *Astr. Nachr.*, V. 57.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1826, March	20.31115	50° 37' 51.6"	+10° 46' 59.4"	+ 5.6	+ 1.3
	27.33788	59 31 6.2		+26.3	
	.33979		10 51 34.1		+24.2
	28.32318	60 48 11.9		+28.0	
	.32585		10 50 57.4		+21.8
	31.32459	64 46 17.7	10 46 53.6	+31.4	+17.8

Bremen. (OLBERS.) Ring-Micrometer. *Astr. Jahrb.*, 1829, 122. *Astr. Nachr.*, IV. 517.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1826, March	28.31986	60° 47' 28.9"	+10° 51' 18.3"	+55.4	+ 1.1
	30.33879	63 27 16.1	10 48 40.4	+48.4	+14.0
	31.31751	64 45 21.9	10 47 8.3	+53.1	+ 3.8
April	7.32855	74 18 36.5	10 24 28.4	+40.3	— 0.5
	8.33709	75 42 27.5	10 19 33.1	+51.8	+ 5.7
	9.33049	77 5 25.3	10 14 28.5	+59.9	+ 3.1
	10.33712	78 29 44.2	10 8 47.8	+70.6	+ 9.4
	25.36352	99 42 46.2 :	8 3 30.8 ::	+42.4 :	—38 0 ::
	30.37106	106 38 31.1	7 6 11.7	+42.0	—16.1

⁽¹⁾ *Nuovi Saggi dell' I. R. Acad. di Padova*, III. 328.

(To be continued.)

LETTER FROM MR. C. W. TUTTLE TO THE EDITOR.

Boston, 1860, May 20.

I HEREWITH enclose the times of the several contacts of the planet *Venus* with the moon on the 24th of April. The place of observation was at the Universalist Church, Gloucester, in this State. The telescope used was the identical one used by Mr. HIND of London to observe the total eclipse of 1851, July 28, and is fully described in the Monthly Notices of that year.

First contact,	^h 8 ^m 42 ^s 7.8	Gloucester M. T.
Disappearance,	8 42 54.8	" "
First reappearance,	9 30 26.3	" "
	9 31 0.8	" "

The time of reappearance is a little uncertain. At the immersion the planet appeared to advance nearly its whole diameter upon the dark limb of the moon.

C. W. TUTTLE.

ON SOME PROPERTIES OF THE GEOCENTRIC MOTION OF A HEAVENLY BODY.

By GEORGE SEARLE.

IF we consider two bodies, e and p , moving about a common center S , under a centripetal force, expressed in the two cases by F and f , so that F is twice the distance which e would move in a mean solar day under the force alone, and f twice that which p would move, if the force did not change in the interval; and if we have at any instant, and for any polar coördinates,

α , β , the position of p as seen from e ;
 A , B , the position of S , also seen from e ;

$$\varrho (d^2\alpha - 2 \tan \beta d\alpha d\beta) + 2 d\varrho d\alpha = \left(\frac{f}{r} - \frac{F}{R}\right) R \cos B \sec \beta \sin (A - \alpha)$$

$$\varrho (d^2\beta + \sin \beta \cos \beta d\alpha^2) + 2 d\varrho d\beta = \left(\frac{f}{r} - \frac{F}{R}\right) R [\sin B \cos \beta - \sin \beta \cos B \cos (A - \alpha)].$$

Denoting now by ds the arc traversed by p as seen from e , $= \sqrt{d\alpha^2 \cos^2 \beta + d\beta^2}$, by $d\eta$ the curvature of ds , positive if the path of p is bending to the right, negative if to the left; and adopting coördinates, the positive pole of which is the nearer center of curvature of the path, we have the equation, deduced from the second of the above,

$$\varrho ds d\eta = \left(\frac{f}{r} - \frac{F}{R}\right) R \sin \epsilon$$

in which ϵ is the distance of S to the right of the path produced in a great circle. The first equation, using the same coördinates, divided by this, becomes

$$\frac{2 d\rho}{\rho} = d\eta \cot \theta - \frac{d^2s}{ds}$$

in which θ is the angle made by the great circle connecting s and p as seen from e with the path, counted from the direction of the motion of p toward the right. This equation is general for all forms of the force.

Two cases seem to be principally worthy of consideration :

R , the distance of S from e ;

also, $\frac{da}{dt}$, $\frac{d^2a}{dt^2}$, $\frac{d\beta}{dt}$, $\frac{d^2\beta}{dt^2}$, in which the unit of time is a mean solar day; (and these quantities may be written simply da , d^2a , $d\beta$, $d^2\beta$;) if r represents the distance of p from S , ϱ its distance from e , and $d\varrho$ the quantity $\frac{d\rho}{dt}$, the unit of time being as before; the two equations for determining ϱ and $d\varrho$ become,

1. The case when f is proportional to r , and has the same proportion that F has to R . We have here

$$\varrho ds d\eta = 0$$

The curvature is then zero in this case, and p as seen from e moves in a great circle. Also,

$$\frac{2 d\rho}{\rho} = - \frac{d^2s}{ds}$$

or $\varrho^2 ds$ is constant, so that p presents, in all respects, the appearance of revolving about e under a centripetal force. This is a simple result of this law of attraction.

2. The case of gravitation, when f is proportional to r^{-2} , and has the same proportion that F has to R^{-2} , which proportion in the solar system is the constant k^2 . For the solar system, then, the first equation becomes

$$\varrho ds = k^2 \left(\frac{1}{r^3} - \frac{1}{R^3} \right) \frac{R \sin \epsilon}{d\eta}$$

e will now represent the earth, p any planet or comet, and S the sun.

Since the first member is always positive, when $r = R$ changes its sign, $d\eta$ also changes, unless $\sin \epsilon$ does; and when $\sin \epsilon$ changes $d\eta$ also changes, unless $r = R$ does. Hence, in each of these cases there is a point of contrary flexure in the path, the second case being that when the sun crosses the path produced. If $r = R$ and $\sin \epsilon$ change sign at the same time, the two points come together, and the curve is merely flattened.

When $r < R$ the sun is always on the concave side of the path produced, since $\sin \epsilon$ and $d\eta$ must have the same sign; and when $r > R$, it is always on the convex side. The latter, then, is always the case for a superior planet, the former for an inferior one.

To return to the general equation. Putting $\frac{r^{n+1}}{h^n}$ for f , and $\frac{R^{n+1}}{h^n}$ for F , h being some constant, we have

$$h^n q ds d\eta = (r^n - R^n) R \sin \epsilon$$

Now, if δ is the angular distance (always $< 180^\circ$) between p and S as seen from e ,

$$\cos \delta = \sin B \sin \beta + \cos B \cos \beta \cos (\alpha - A),$$

and if z is the angular distance (always $< 180^\circ$) between e and S as seen from p ,

$$R \sin \delta = r \sin z$$

$$q = R \frac{\sin (z + \delta)}{\sin z}$$

$$\frac{\sin (z + \delta)}{\sin z} = \frac{R^n \sin \epsilon}{h^n ds d\eta} \left(\frac{\sin^n \delta}{\sin^n z} - 1 \right)$$

which may be written

$$\frac{\sin (z + \delta)}{\sin z} = m \left(\frac{\sin^n \delta}{\sin^n z} - 1 \right)$$

$$\sin z (m + \cos \delta) + \sin \delta \cos z = m \frac{\sin^n \delta}{\sin^{n-1} z}$$

and if

$$\frac{\sin \delta}{m + \cos \delta} = \tan q$$

$$\sin (z + q) = m \sin q \sin^{n-1} \delta \sin^{1-n} z$$

In the case of gravitation, $n = -3$

$$\sin (z + q) = m \frac{\sin q}{\sin^4 \delta} \sin^4 z$$

Also, $h = k^3$ and $m = \frac{k^2 \sin \epsilon}{R^3 ds d\eta}$

The expression for m in coördinates is

$$\frac{k^2}{R^3} \cdot \frac{\sec \beta \cos B \sin (\alpha - A) \frac{d\delta}{d\alpha} + \sin B \cos \beta - \sin \beta \cos B \cos (\alpha - A)}{d^2 \beta + \sin \beta \cos \beta d\alpha^2 + 2 \tan \beta d\beta^2 - d^2 \alpha \frac{d\delta}{d\alpha}}$$

The equation for determining z above has the same form as that of GAUSS. Supposing it to be identical with it, we have

$$q = -(\omega + v)$$

$$m \frac{\sin q}{\sin^4 \delta} = \frac{Q \sin \omega}{2 R^3 \sin^3 \delta \sin \sigma}$$

Combining these,

$$m = -\frac{Q (P + a) \sin \delta}{2 b R^3 (P + 1) \sin \sigma}$$

and from the first alone,

$$m = \frac{\sin \delta}{\sin \sigma} \left(\frac{P + a}{b (P + 1)} - \cos \sigma \right) - \cos \delta$$

Hence,

$$Q = 2 R^3 \frac{\sin (\delta + \sigma) b (P + 1)}{\sin \delta (P + a)}$$

This equation is not correct, but it will be if the values of P and Q for the orbit of the earth are used instead of those for the body. Now these are identical if the intervals of the times are small and nearly equal. Now we can determine $d\alpha$, $d\beta$, $d^2\alpha$, $d^2\beta$ from three observations in this case, but in no other one; hence, when three observations can properly be used for the computation of an orbit by this method, the z equation is the same as that deduced from the same data by the method of GAUSS, as might be expected. If the intervals of the times are very small and equal, the first equation given for m above also becomes identical with

$$m = \frac{k^2 \sin \epsilon}{R^3 ds d\eta}.$$

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NO. 16.

ON BIELA'S COMET.

BY PROFESSOR J. S. HUBBARD

OF THE WASHINGTON OBSERVATORY.

II. — (*Continued.*)

§ 8. OBSERVATIONS.

Florence. (INGHIRAMI.) *Ring-Micrometer.* *Astr. Nachr.*, IV. 529 ; V. 25, 50. *Corr. Astr.*, XIV. 492.

Date.	M. T. Greenwich.	α	δ	C. — O.		Corrections of Record.
				$\Delta\alpha$	$\Delta\delta$	
1826, Mar.	19.32931	49° 25' 31".8		+15.8		Apr. 1, Record of first obs. confused and unintelligible.
	.33591	26 6.2	+10° 44' 57.1	+10.4	+ 6.6	
	.33623	26 6.0	45 0.9	+12.0	+ 2.9	Apr. 2, for 13' 48".0 read 12' 48".0 13 58.8 12 58.8
Apr.	1.37026	66 10 16.5	10 44 58.2	+36.2	0.0	
	2.32965		10 42 22.4		+12.4	Apr. 3, for 22 22.4 read 22 2.4 25 59.6 24 59.6 33 59.2 32 59.2 43 51.6 42 51.6
	.32991	67 28 7.3		+22.1		
	3.34050	68 49 59.5	10 39 21.5	+41.7	+19.6	
	4.33269	70 11 17.8		+31.9		
	5.33510	71 33 33.7	10 31 58.2	+40.3	+51.7	
	6.34955	72 57 31.8	10 28 35.5	+30.4	+10.4	
	7.32129	74 17 53.6	10 24 27.0	+46.8	+ 2.8	
	8.32621	75 41 43.1	10 19 43.2	+41.7	— 1.0	
	9.31939	77 4 54.7	10 14 33.2	+34.7	+ 1.9	
	10.29320	78 26 42.9		+30.3		
May	2.35578	109 21 5.2	6 41 8.5	— 4.7	+42.8	
	8.35385	117 16 28.1		+ 4.4		

Göttingen. (HARDING.) *Ring-Micrometer.* *Astr. Nachr.*, IV. 435 ; V. 152.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1826, Mar.	12.31537	41° 8' 1.2	+10° 22' 48".9	+17.5	+ 9.9
	13.29540	42 15 51.5	10 26 22.6	+ 2.0	+28.7
	14.28883	43 24 46.4	10 30 11.6	+16.1	+20.4
Apr.	8.32818	75 41 51.3	10 19 39.4	+43.3	+ 2.2
	9.34113	77 6 34.4	10 13 41.5	+44.2	+46.7
	27.37416	102 31 15.5		+16.6	
	.37994		7 40 34.7		+ 4.8

Josephstadt. (BIELA.) *Astr. Nachr.* IV. 433. *Astr. Jahrb.* 1829, 117.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1826, Feb.	28.28739	28° 11' 16.3	+ 9° 18' 47.5	— 13.9	+ 21.2
March	2.30515	30 14 26.0	9 31 43.4	+ 16.4	— 7.6
	3.28504	31 15 38.3	9 36 51.9	+ 5.7	+ 34.1
	4.28161	32 18 45.4		— 18.1	
	7.28122	35 31 18.5	9 59 32.1	— 3.9	+ 3.1
	11.26871	39 56 8.4	10 18 40.4	+ 42.0	— 5.3
	12.27712	41 5 50.4	10 22 52.6	— 9.2	— 3.2
	29.32813	62 10 34.6	10 47 21.3	(—162.3)	(+176.6)

Mannheim. (NICOLAI.) *Ring-Micrometer.* *Astr. Nachr.*, V. 53.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1826, April	1.33065	66° 7' 9.9	+10° 44' 50.2	+31.1	+13.5
	8.33330	75 42 16.4	10 19 33.6	+13.9	+ 6.5
	9.32552	77 5 19.3	10 14 16.3	+40.8	+16.8

Marseilles. (GAMBART.) *Astr. Nachr.*, V. 125.

Date.	Greenwich M. T.	α	δ	C. — O.		Remark.
				$\Delta\alpha$	$\Delta\delta$	
1826, March	9.31892	37° 45' 36.3	+10° 9' 37.7	+ 2.2	+ 5.7	
	11.30795	39 59 13.2	10 18 15.7	+17.3	+29.5	
	13.28909	42 15 14.0	10 26 24.7	+13.3	+25.1	
	15.30613	44 36 14.3	10 33 59.8	+17.2	+ 2.1	
	17.30377	46 58 34.3	10 39 44.8	+17.0	+20.2	
	19.29333	49 22 37.2	10 44 42.8	+32.4	+15.4	
	21.30717	51 51 15.5	10 48 14.0	+30.9	+27.9	
	27.30978	59 28 33.6	10 52 8.1	+47.4	— 8.9	
April	1.31723	66 5 49.8	10 44 46.3	+46.3	+19.2	α recorded 59° 43'
	3.31083	68 47 14.7	10 39 38.3	+61.2	+ 8.5	
	4.31077	70 9 16.7	10 36 17.3	+45.1	+15.1	
	5.31879	71 32 7.8	10 32 45.3	+45.5	+ 8.3	
	9.33119	77 5 32.0	10 14 10.5	+56.7	+20.8	
	28.32881	103 49 27.5	7 29 16.5	(+82.4)	+17.7	
	30.34962	106 37 1.8	7 5 26.6	+25.8	+26.1	

Milan. (CARLINI.) *Equatorial Sector.* *Corr. Astr.*, XIV. 396.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1826, March	29.34445	62° 8' 28.0	+10° 49' 53.7	+ 41.4	+23.1
	30.31168	63 26 50.0	10 48 47.7	+ 88.3	+ 6.4
	31.32181	64 46 10.8	10 46 57.6	+ 24.9	+14.0
April	1.29861	66 3 19.4	10 44 58.5	+106.6	+ 9.6
	2.29255	67 24 56.3	10 42 5.4	+ 31.3	+35.2
	4.33871	70 12 1.0	10 36 35.8	+ 18.3	— 9.3
	5.30623	71 31 18.6	10 32 49.6	+ 32.6	+ 6.9
	6.29679	72 51 57.4	10 28 56.5	+102.6	+ 2.7
	7.30147	74 15 49.5	10 24 54.6	+ 72.2	—19.3
	3.5035	20 2.1	24 7.9	+ 63.4	+13.8
	8.33185	75 42 18.0	10 20 27.8	+ 35.0	—47.3
	9.32819	77 5 26.9	10 15 4.8	+ 46.8	—32.5

Naples. (BRIOSCHI.) *Equatorial. Astr. Jahrb.*, 1829, 150.

Date.	M. T. Greenwich.	α	δ	C. — O.		Corrections of Record.
				$\Delta\alpha$	$\Delta\delta$	
1826, Mar.	31.30430	64° 44' 24.2	+10° 46' 51.6	+47.3	+22.0	
April	1.30707	66 5 26.9	10 44 51.1	+19.9	+15.9	
	4.32506	70 10 48.2	10 36 28.7	+23.9	+ 0.8	
	8.31124	75 40 52.7	10 19 50.7	+17.1	— 4.1	
	10.28148	78 25 53.6	10 9 16.5	+20.6	— 0.1	
	15.29540	85 29 39.0	9 35 37.2	+38.4	+19.9	
	27.33563	102 27 42.3	7 40 27.0	+37.4	+42.5	
May	1.30908	107 56 2.7	6 53 53.6	— 7.3	+44.9	May 1,
	5.31851	113 18 48.8	6 4 35.7	—11.7	+ 3.9	for 58° 31' 46" read
	7.31926	115 57 59.1	5 37 28.5	+28.3	+58.0	59° 31' 46".
	8.33814	117 15 1.7	5 25 33.8	+17.9	— 4.1	
	9.35366	118 33 51.5	5 11 44.0	—16.8	+22.3	

Nismes. (VALZ.) *Corr. Astr.*, XIV. 397.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1826, March	29.38580	62° 11' 9.2	+10° 50' 40.7	+76.9	—26.9
	30.32237	63 26 8.7	10 50 3.3	+37.4	—67.4
	31.37814	64 50 10.3	10 47 17.7	+56.3	—12.7
April	1.35955	66 9 9.2	10 45 7.6	+51.7	— 7.9
	2.37741	67 31 40.3	10 43 48.7	+40.2	—81.7
	3.36559	68 51 41.3	10 39 30.7	+62.6	+ 5.8
	4.36357	70 13 24.3	10 36 12.7	+57.2	+ 8.8
	5.36969	71 36 17.3	10 32 9.7	+47.8	+32.2
	6.36435	72 58 9.3	10 29 39.7	+66.4	—57.5

Padua. (SANTINI.) *Equatorial. Corr. Astr.*, XIV. 583.

Date.	Greenwich M. T.	α	δ	C. — O.		Remarks.
				$\Delta\alpha$	$\Delta\delta$	
1826, Mar.	25.27942	56° 52' 8.6	+10° 52' 39.4	+ 3.3	—25.1	
	.28898	52 35.4	52 19.0	+20.6	— 4.6	
	29.30203	62 5 28.3	10 49 48.8	+20.2	+31.0	March 29,
	31.27620	64 42 38.5	10 47 28.3	+17.8	— 8.5	for 10° 58' 28" read
	.28570	43 18.0	47 20.7	+24.1	— 2.0	10° 53' 28".
April	1.27972	66 3 13.5	10 44 41.3	+21.1	+29.4	
	.29084	3 54.1	44 53.4	+34.3	+15.8	
	4.28889	70 7 43.3	10 36 17.0	+30.9	+19.9	
	7.30098	74 16 55.8	10 25 23.4	+ 3.4	—47.9	Comet faint.
	.33094	19 36.4	24 19.1	— 7.8	+ 8.0	
	8.30451	75 40 16.2	10 19 30.2	+19.8	+18.4	
	.33561	42 55.5	19 27.8	+16.3	+11.6	
	11.29198	79 51 9.9	10 2 5.1	+ 8.9	+73.6	
	15.31413	85 31 28.8	9 35 17.1	+24.1	+31.4	
	.32641	32 39.4	34 42.1	+16.1	+60.9	
May	1.35467	107 59 37.0	6 54 24.3	+ 1.6	—18.8	
	2.34790	109 21 23.6	6 41 27.2	—61.4	+29.9	
	.36158	22 26.8	41 46.0	—58.0	+ 1.0	

Prague. (DAVID.) *Astr. Nachr.*, V. 63.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1826, March	31.32039	64° 45' 59.2	+10° 47' 26.8	+29.7	— 15.1
April	1.29112	66 3 44.0	10 45 34.6	+45.8	— 25.4
	8.32698	75 42 16.8	10 17 47.5	+11.8	(+114.5)
	9.31952	77 4 34.6	10 15 24.6	+55.3	— 49.5

Spire. (SCHWERD.) Ring-Micrometer. *Astr. Beob. in Speyer.*, 1828, 106.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1826, March	10.29446	38° 50' 58".0	+10° 13' 59".7	— 0.1	+16.0
	11.29946	39 58 49.0	10 18 25.8	+ 6.8	+17.3
	12.30744		10 22 38.4		+18.5
	.31424	41 8 2.8		+11.3	
	13.29653	42 15 54.0	10 26 48.4	+ 4.1	+ 3.1
	16.28958	45 45 54.1	10 36 42.1	+22.1	+26.9
	.28958	46 1.0	36 55.0	+15.2	+14.0
April	1.30766	66 5 3.9	10 44 44.1	+45.9	+22.7

Upon reviewing the above observations it is at once evident that the series at Milan and Nismes are decidedly inferior to the rest in accuracy; while all the others appear entitled to about the same relative weight. I have therefore omitted these two series, together with three or four individual observations among the others, as already indicated by the parentheses. The sequence of dates is interrupted twice by the intervention of full moon rendering the comet invisible for a few days. For each of the three groups of observations thus produced I have taken the mean of the residuals, giving the weight of unity to each day's determination by each observer, and thus have found the following normal residuals and places as representative of the comet's motion at this appearance: —

	Greenwich M. T.	O. — C.		α	δ	No. of Observations.	
		$\Delta\alpha$	$\Delta\delta$			α	δ
VI.	1826, Mar. 12.0	—10.2	—13.4	40° 46' 31".8	+10° 21' 27".8	24	23
VII.	Apr. 5.0	—36.6	—10.5	71 6 2.0	10 33 54.6	56	53
VIII.	May 3.0	— 8.3	—15.5	110 12 57.3	6 33 37.6	14	13

§ 9.

From the above normals I have deduced the following more correct elements, retaining SANTINI's value of μ .

ELEMENTS, 1826.

Greenwich M. T. Mean Equinox 1826.0.

M , Mar. 18.0	359° 56' 42.0 +	1.097 $\Delta\mu$	T Mar. 18.44662
Ω_0	325 5 12.21 +	12.706 $\Delta\mu$	Ω 251° 27' 18.85
ω_0	142 3 52.97 —	4.315 $\Delta\mu$	ω 218 21 28.50
i_0	22 51 47.04 +	2.970 $\Delta\mu$	i 13 33 54.05
φ	48 17 48.55 —	94.125 $\Delta\mu$	
μ	527.960 +	1. $\Delta\mu$	

RESIDUALS.

	$\Delta\alpha$	$\Delta\delta$
March 12	—0.5	+1.8
April 5	+0.1	—3.2
May 3	+0.4	+1.6

§ 10. FOURTH APPEARANCE, 1832.

The return of the comet at this its first predicted reappearance was anxiously awaited, and SANTINI's ephemeris proved of great service in facilitating the discovery. The comet was reported to have been seen at Rome ⁽¹⁾ as early as the 25th

of August, and observed until September 20; but, so far as I can ascertain, no observations were published, and the report doubtless originated in some misconception.

The first recorded view was obtained by SIR JOHN HERSCHEL, at Slough, with his 20-foot reflector, on the 23d of September, at which time, and on the following night, he

(¹) *Astr. Nachr.*, X. 293.

succeeded, though not without the greatest difficulty, in obtaining tolerably good observations of its place. After this, it was again found by GAMBART and VALZ, on the 19th of October, and was thenceforward regularly observed, except when lost in moonlight, until January 3, when it was last seen by HENDERSON, at the Cape of Good Hope.

During the whole of this appearance, the comet was very faint, almost entirely round, and with only a slight condensation near, not in the center, but on the side nearest the sun. On the 6th of November, STRUVE saw the comet pass almost exactly centrally over a star of the 9 magnitude, whose light, compared with that of another of the same magnitude outside of the comet, was not diminished in the least.⁽¹⁾ But a more striking proof of the extreme transparency peculiar to this class of bodies was afforded to HERSCHEL⁽²⁾ on the 23d of September, when the comet passed over a small cluster or knot of stars of the 16 or 17 magnitude, which, as he remarks, the most trifling fog would have instantly effaced, and which yet were perfectly visible through the comet, giving it the appearance of a partially resolved cluster, or nebula. On the 28th of November, two days after the perihelion-passage,

the comet appeared remarkably bright; no other change was noticed by any observer, the general remark being only that the comet was very difficult of observation.

§ 11.

We are fortunate, in connection with this appearance of our comet, in having, from the hands of BESSEL and STRUVE, two invaluable series of observations, extending from October 20 to November 28, and furnishing abundant material, almost to exclusiveness, for the determination of the orbit. And then we have also the results of a thorough discussion of these observations, made by BARANOWSKI under the auspices of BESSEL, and which, as remarked by the latter, and as shown by the residuals themselves, completely exhaust the power of the observations. The only thing left for wish is, that this skilful computer had included also the later positions, and especially those obtained by HENDERSON, which extend into January, 1833.

BARANOWSKI's elements, put into uniform shape with those for the previous appearances, are as follows:—

ELEMENTS, 1832.

Greenwich M. T. Mean Equinox 1833.0.

<i>M</i> , Nov. 26.0	359° 58' 57".65 —	2.234 <i>Δμ</i>	<i>T</i> Nov. 26.116882
<i>Ω</i> ₀	325 33 13.57 +	12.757 <i>Δμ</i>	<i>Ω</i> 248° 15' 17".86
<i>ω</i> ₀	141 54 50.14 —	21.668 <i>Δμ</i>	<i>ω</i> 221 45 6.81
<i>i</i> ₀	22 4 0.52 —	7.413 <i>Δμ</i>	<i>i</i> 13 13 30.96
<i>q</i>	48 42 57.49 —	93.879 <i>Δμ</i>	
<i>μ</i>	533.4396 +	1. <i>Δμ</i>	

The value of *μ* here given is that corresponding to DAMOISEAU's instantaneous value of *a*.

§ 12.

For the sake of completeness, I copy here the observa-

tions of BESSEL and STRUVE, as reduced and compared by BARANOWSKI, remarking that the positions are corrected neither for aberration nor parallax, these corrections having been applied with reversed sign to the ephemeris before each comparison.

Dorpat and Königsberg. (STRUVE and BESSEL) *Astr. Nachr.*, XIII. 243; XIV. 178.

Date.	Paris M. T.			C. — O.		Observatory.
				<i>Δα</i>	<i>Δδ</i>	
1832, Oct.	20 11 ^h 45 ^m 14.8 ^s	131° 36' 32".51	+22° 15' 2".88	+0.71	+4.52	Königsberg.
	20 13 10 50.8	131 42 37.86	22 11 45.42	+2.75	—1.04	Dorpat.
	23 15 3 19.7	136 56 4.95	19 9 45.70	—2.82	—2.32	"
	25 11 52 25.6	140 0 28.69	17 14 46.35	+2.74	—4.39	Königsberg.
	25 15 25 36.9	140 14 49.75	17 5 25.04	+1.72	+4.99	Dorpat.
	26 15 6 29.5	141 50 16.54	16 3 37.30	—2.78	+3.13	"
	27 15 59 18.9	143 28 15.94	14 58 39.52	+2.69	+0.42	Königsberg.
	29 15 25 45.2	146 33 4.30	12 52 27.08	—1.43	+5.52	"
	30 15 40 57.2	148 5 0.66	11 48 6.89	—0.78	+1.47	"
	Nov. 2 15 47 28.9	152 29 48.29	8 37 31.19	—1.09	+3.75	Dorpat.
Nov.	2 16 10 0.8	152 31 9.56	8 36 37.58	—1.14	—1.35	Königsberg.
	6 16 24 43.5	158 5 4.76	+ 4 28 41.10	—1.79	—1.91	Dorpat.
	20 15 34 12.2	175 0 20.11	— 8 0 0.12	—0.62	—1.19	Königsberg.

⁽¹⁾ *Astr. Nachr.*, XII. 29.

⁽²⁾ *Mem. R. Astr. Soc.*, VI. 99.

Date.	Paris M. T.	α	δ	C. — O.		Observatory.
				$\Delta\alpha$	$\Delta\delta$	
1832, Nov.	21 16 ^h 19 ^m 19.3 ^s	176° 7' 51".01	— 8° 46' 53".98	—1".04	—1".14	Königsberg.
	21 16 26 45.3	179 19 46.61	10 56 57.23	+6.05	—0.32	Dorpat.
	25 15 29 13.0	180 19 53.31	11 36 24.54	—0.49	—3.01	Königsberg.
	25 16 3 32.1	180 21 19.36	11 37 25.76	+0.59	—0.50	Dorpat.
	26 15 55 56.1	181 22 45.26	12 17 16.91	+1.30	—3.40	"
	26 16 29 50.6	181 24 12.79	12 18 17.75	+0.68	+1.75	Königsberg.
	26 16 30 30.5	181 24 6.00	12 18 22.03	+8.41	+4.59	Dorpat.
	27 16 3 31.3	182 24 15.89	12 56 34.67	—4.20	—3.43	"
	28 16 29 3.6	183 25 43.22	—13 35 22.92	—0.93	+0.81	"

I now add HERSHEL's observations, the only ones previous in date to those of the above list, together with such later observations as I have been able to find.

Slough. (HERSCHEL.) *Mem. R. Ast. Soc.*, VI. 99.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1832, Sept.	23.65142	85° 3' 25".7	+36° 17' 54".1	+ 18.4	— 4.5
	.69153	7 13.5	16 48.0	+ 10.6	+46.4
	24.57075	86 27 15.2	+36 11 25.6	+ 68.4	— 1.2
	.59132	28 8.5	10 25.1	+129.8	+49.8
	.61230	30 46.8	11 24.7	+ 88.3	—19.5

Cape of Good Hope. (HENDERSON.) *Mem. R. Ast. Soc.*, VIII. 242.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1832, Dec.	26.51707	207° 55' 34".5		+ 3.7	
	.51734		—25° 49' 32".0		+13.7
	31.53944	211 39 39.0	27 11 4.0	+28.6	+28.7
1833, Jan.	1.57277	212 24 24.0	27 26 22.0	+19.9	+29.8
	2.56539	213 6 58.5	27 40 1.0	+ 5.7	— 5.6
	3.59003	213 50 0.0	—27 51 50.0	+14.9	+27.9

(To be continued.)

LETTER FROM PROFESSOR KIRKWOOD TO THE EDITOR.

Bloomington, Indiana, 1860, July 2.

I HAVE discovered the following inequalities of long period between the planets *Mars* and *Astrea*, *Jupiter* and *Calliope*, and *Jupiter* and *Clio* : —

(1.) $11n^{\text{IV}} - 5n^{(5)} = 1744''$. This indicates an inequality whose period is about 743 years.

(2.) $n^{\text{V}} - 3n^{(22)} = 948''$; corresponding to an inequality whose period is about 1367 years.

(3.) $3n^{(12)} - 10n^{\text{V}} = 1106''$; corresponding to an inequality whose period is about 922 years.

I have noticed several others between the asteroids and the old planets, but perhaps the elements of the former are not well enough determined to give trustworthy results.

The fact has doubtless been noticed, that five times the mean motion of *Psyche* is almost precisely equal to the mean motion of the earth. Perhaps it may also be worthy of remark, that if the time (19^d.25) adopted by WOLF as the period of the intra-Mercurial planet be correct, nineteen of its periods will exceed one of the earth's by only 12 hours; and consequently transits, or at least conjunctions, of the planet would occur for several consecutive years at nearly the same time.

The mean motion of *Calliope* adopted in equation (2) corresponds to the *period* given in the Supplement to the *American Ephemeris* for 1861. The mean motion there given is incompatible with the period and distance.

DANIEL KIRKWOOD.

FROM A LETTER OF PROFESSOR BRUHNS TO THE EDITOR.

Leipsic, 1860, May 13.

THE new observatory is to be commenced forthwith, and after little more than a twelvemonth, either July 1 or October 1 of the next year, I hope to begin work in it.

My chief instrument will be an equatorial with two 24-inch circles and microscopic reading, the telescope having 12 feet focal length and an aperture of 8 inches. The object-glass is to come from STEINHEIL, in Munich, but the rest of the instrument, however, from PISTOR and MARTINS, in Berlin, and to be completed in a year and a quarter.

In addition to this, I shall have, as a beginning, the use of the instruments now here, among which, the Fraunhofer refractor of 6 feet focal length, parallactically mounted, another Fraunhofer telescope of 3½ feet focus, and a 3-foot transit-instrument by RAMSDEN, are especially to be mentioned.

At present I am living in the *Pleissenburg*, and shall do what I can towards making a few observations here.

Though I am much occupied with my lectures, I hope to find time for sundry other investigations, and especially for the computation of the BRORSEN comet.

For the fifty-eighth small planet, *Concordia*, I have lately

computed the following elements, which I consider tolerably accurate : —

Mean Equinox 1860.0.

Epoch = 1860, April 10.0

$M = 63^{\circ} 18' 46''.8$

$\pi - \Omega = 314^{\circ} 26' 20.9$

$\Omega = 162^{\circ} 3' 25.1$

$i = 5^{\circ} 15' 31.3$

$q = 2^{\circ} 57' 40.0$

$\mu = 808''.640$

$\log a = 0.428168$

The constants for computing the finding ephemeris are,

$\log x = \log r + 9.99983 + \log \sin (206^{\circ} 34.5 + v)$

$\log y = \log r + 9.97709 + \log \sin (117^{\circ} 6.9 + v)$

$\log z = \log r + 9.50200 + \log \sin (111^{\circ} 44.5 + v)$

C. BRUHNS.

THIRD COMET OF 1860.

A BRILLIANT comet, visible to the naked eye, and having a tail several degrees in length, was seen by many persons in this country on the evenings of June 21st and 22d; reports of its detection on those dates having been forwarded to the Editor of this Journal by a great number of persons in various parts of the United States, from Maine to New Mexico. It appears to have been independently detected by fifty or a hundred people, before any public announcement was made. Very early accounts were sent in by Rev. Prof. WYLIE, of the State

University of Indiana, and JOHN HAYWOOD, Esq., of Westerville, Ohio. The earliest authentic account of its detection comes from Prof. CASWELL, of Providence, who writes that he saw the comet from the deck of the steamship Arabia, on the evening of June 20. The first public notice seems to have been made through the columns of a newspaper by Mr. TUTTLE, the zealous and successful comet-discoverer.

Commander MAURY, of the Washington Observatory, has communicated the following observations by Mr. FERGUSON :

OBSERVATIONS OF THE COMET 1860 III.

MADE WITH THE WASHINGTON EQUATORIAL.

[Corrected for refraction.]

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ — *		$\Delta\delta$		α ^s apparent		δ	
				$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha$	$\Delta\delta$	α	δ	α	δ
1860, June	22	3	596 Gr. 12 - Y.	—3 14.07	+17' 39.41	6 37 39.09	+42 14' 13.23				
	25	4	B. Z. 492, 6	—0 7.21	—8 55.11	7 5 58.90	42 1 36.89				
	30	2	Lalande, 15888	+2 50.00	+10 50.61	8 4 10.02	37 56 22.00				
July	1	8	B. Z. 451, 92	—2 5.96	+6 1.88	8 16 59.94	36 27 2.68				
	4	7	B. A. C. 3109	—2 39.53	+11 59.43	8 56 57.56	30 24 47.14				
	9	8	* 3	+0 9.05	—3 46.27						
	10	6	Weisse, X. 209	+1 41.34	+13 10.88	10 14 42.39	+12 16 21.29				

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
596 Gr. 12-Y.	5	^h 6 ^m 40 ^s 51.66	+41° 56' 30".11	Greenwich Catalogue.
B. Z. 492. 6	7	7 6 4.57	42 10 28.61	Bessel's Zones.
Lalande, 15888	9	8 1 18.47	37 45 29.53	Lalande's Catalogue.
B. Z. 451, 92	7	8 19 4.15	36 20 59.87	Bessel's Zones.
B. A. C. 3109	7	8 59 35.38	30 12 48.68	British Association Catalogue.
Weisse, X. 209	8	10 12 59.27	+12 3 17.47	Weisse's Catalogue.

The stars of comparison for the observations of the 22d and 25th of June are doubtful, as well as that for the comparison of 9th July. The comet was observed on the nights of the 23d, 24th, 26th, 28th, and 29th of June, but there were no stars visible with which to compare it.

Professor PETERS has published the following observations, made June 23:—

Place.	Mean Time.	α	δ	Observer.
	^h ^m ^s	^h ^m ^s		
Bonn,	11 8 40	6 45 9	+42° 18' 30"	WINNECKE.
Altona,	11 18 34	6 45 7.5	42 18 24.3	HOEK.
Bonn,	12 40 37	6 45 43.12	42 18 42	KRUEGER.

Mr. TUTTLE has sent the following letter, giving elements:—

LETTER FROM MR. C. W. TUTTLE TO THE EDITOR.

Boston, 1860, July 5.

I HAVE derived the following parabolic elements of the comet discovered by Mr. H. P. TUTTLE on the 21st of June, from observations made at the Harvard College Observatory, on the 21st, 24th, and 27th of June.

The middle place is represented as follows: (C. — O.)

$$\Delta\lambda = -2'; \quad \Delta\beta = +5''.$$

$$\begin{aligned} T &= 1860, \text{ June } 16.06730 \\ \pi &= 161^\circ 34' 56'' \text{ Mean Equinox,} \\ \Omega &= 84 41 20 \text{ } 1860, \text{ Jan. 0.} \\ i &= 79 18 11 \\ \log q &= 9''.46687 \\ &\text{Motion Direct.} \end{aligned}$$

C. W. TUTTLE.

The comet remained easily visible to the naked eye for about two weeks.

Mr. SEARLE has computed, from observations at Washington, June 22, July 1, and 10, the following parabolic elements, which represent the middle observation within +49'' in longitude, and +50'' in latitude.

$$\begin{aligned} T &= \text{June } 15.8460 \\ \pi &= 161^\circ 37' 34'' \\ \Omega &= 84 40 29 \text{ } \text{Mean Equinox } 1860.0. \\ i &= 79 18 33 \\ \log q &= 9''.467466 \end{aligned}$$

The middle place may perhaps be more accurately represented; but it appears, according to Mr. SEARLE, as though a nearer accordance than 40'' in distance were hardly attainable by any parabolic orbit.

1860, July 16.

G.

CORRIGENDA.

No. 130, page 78, column 3, in the heading, *for* δ *read* α .

134, " 111, " 1, line 35, *for* BURG *read* BURY.

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THE ASTRONOMICAL JOURNAL.

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NO. 17.

ON BIELA'S COMET.

By PROFESSOR J. S. HUBBARD

OF THE WASHINGTON OBSERVATORY.

II. — (Continued.)

§ 12. OBSERVATIONS.

Florence. (INGHIRAMI.) *Astr. Nachr.*, XI. 39.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1832, Dec.	23.70411	205° 44' 23".9	—24° 58' 13".0	+ 1".2	— 4".0
	25.71196	207 17 49.7	25 34 28.0	+39.1	—39.3
	27.70276	208 49 22.5	—26 9 42.2	+24.1	+ 7.6

Milan. (KREIL.) *Eff. di Milano*, 1834, 68.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1832, Dec.	21.70263	204° 8' 21".3		+19".6	
	.70872		—24° 19' 52".3		+22".0
	23.71680	205 44 59.9		+ 1.3	
	.71941		24 59 6.8		+32.5
	24.71614		25 17 32.9		+25.8
	.71854	206 31 58.2		+13.1	
	25.70061	207 17 47.0		+10.2	
	.70119		—25 35 6.9		+11.2

Padua. (SANTINI.) *Opuscoli Astronomici*, 23.

Date.	Greenwich M. T.	α	δ	C. — O.	
				$\Delta\alpha$	$\Delta\delta$
1832, Dec.	26.70371	208° 4' 8".2	—25° 52' 23".0	+ 4".2	— 9".4

The mean of the Slough residuals, duly applied to the tabular place for September 24.0, gives a normal for that date, which, in view of the difficulties attending the observations and the probable uncertainty of the results, I have retained only for comparison. BARANOWSKI'S residuals are separated into two groups by a considerable interval of time. The mean for each group, duly applied to his computed places for October 27 and November 24, gave two normals of remarkable accuracy, which, corrected on account of the small difference of solar tables, and reduced to the meridian of Greenwich, are given below as IX. and X. Finally, the remaining observations give normal XI.

	Date. Greenwich M. T.	O. — C.		α	δ	No. of Observations.	
		$\Delta\alpha$	$\Delta\delta$			α	δ
IX.	1832, Sept. 24.0	—63. ^u 1	—14. ^u 2	85° 31' 37. ^u 3	+36° 15' 17. ^u 7	2	2
	Oct. 27.0	+ 0.1	— 1.1	142 26 30.1	+15 39 53.6	12	12
X.	Nov. 24.0	— 1.0	+ 0.6	178 37 18.1	—10 28 25.5	10	10
XI.	Dec. 26.0	—14.3	—10.8	207 31 34.3	—25 40 24.7	13	13

§ 13. FIFTH APPEARANCE, 1845–46.

Among all the observed appearances of this comet, none can compare in interest or importance with that of 1845–46. It was important not only by reason of the long continuance of visibility, extending from November 28 to April 27, during which time the comet passed over a heliocentric arc of 170°, divided exactly in the middle by the perihelion-point, but also because this arc was covered by an almost unbroken series of excellent observations, promising an unusually accurate determination of elements, which might serve as a good basis for more extended investigations.

But the main feature of interest at this occasion was the duplication of the comet, an event which, so far as we can yet learn, seems in no wise to have affected the motions of the primary nucleus. When, and under what circumstances, did this strange event happen? Respecting the cause and manner of occurrence we shall always be left to conjecture; it yet remains to be seen whether the *time* can be indicated with any degree of certainty, and if this be possible, the conditions of time, and consequently of place, being given, the field of conjecture will become more limited, and it may yet be possible to say that only causes of a certain class could have operated under these conditions.

As might be expected, we have, on this occasion, more detailed accounts of the physical phenomena of the comets than at any previous visit. The principal difference in the aspect of the primary nucleus from that at former returns seems to have consisted in a change from the shape hitherto presented, at least since 1772. In 1805, when close to the earth, it was entirely round and tailless⁽¹⁾; in 1832, STRUVE expressly states that the comet exhibited no trace of a tail, only that the nucleus was eccentrically placed within the coma,⁽²⁾ and HERSCHEL, with his 20-foot reflector, saw “no decided tail,”⁽³⁾ while now, in the same telescope at Dorpat, in its counterpart at Washington, as well as to observers in many other places, and especially at Pulkowa, it presented an irregular figure with a tail, whose length was variously stated — according to the optical capacity or to the transparency of the atmosphere — as a simple trace, or as reaching to 45'. STRUVE mentions particularly, on the 19th and 21st of February, a protuberance or prolongation in the primary nucleus extending in a southwest direction, and along the line of which the light was more intense than in the rest of the coma⁽⁴⁾; this is doubtless iden-

tical with the second tail seen at that time by MAURY,⁽⁵⁾ and by PETERS at Naples.⁽⁶⁾

There were also manifested at this time strange variations of light in the two nuclei, which were afterward, in 1852, so decidedly exhibited as to amount to actual alternations of visibility from day to day. The most striking instance of this alternation in 1846 was at the perihelion, when the secondary became suddenly very bright and the primary quite faint; but besides this, we find that although the companion was first recognized on the 29th of December, by HERRICK and BRADLEY, at New Haven,⁽⁷⁾ it was not again seen until MAURY refound it on the 13th of January. Moreover, I have shown elsewhere that there is some reason to suspect that the earliest observations obtained by CHALLIS, on the 1st and 3d of December, refer to this secondary nucleus,⁽⁸⁾ even then visible by fits, and capricious as ever. Whether these alternations of light and this changed form stand in the relation of cause or effect with the mysterious disruption, is matter for conjecture only.

§ 14.

With the view of obtaining all the information possible respecting the motions of the two comets, I have collected and discussed elsewhere,⁽⁹⁾ as far as was practicable at the time, all the observations of both nuclei in 1845–46. I then found elements for each nucleus, which satisfactorily represented the observations, but in which, notwithstanding the unusually favorable conditions, it was impossible to determine the mean motions with sufficient certainty. I therefore subsequently⁽¹⁰⁾ connected the places observed at this time with those determined in 1852, by help of SANTINI's approximate values of the perturbations during the interval,⁽¹¹⁾ recomputing δM and $\delta\mu$ by way of verification. Assuming that the nucleus known in 1846 as the primary is identical with the one which preceded in 1852, I soon obtained $\Delta\mu = +0''.36088$, a value which is still liable to correction after a more complete calculation of the perturbations, but which, adopted for the present and substituted in my Elements III.,⁽¹²⁾ gives the subjoined orbit for the primary nucleus: the differences of elements, elsewhere obtained,⁽¹³⁾ give the orbit for the secondary.

(1) *Astr. Jahrb.*, 1809, 140.

(2) *Astr. Nachr.*, XII. 20.

(3) *Mem. R. Ast. Soc.*, VI. 106.

(4) *Bulletin de l'Acad. Imp. de St.-Petersbourg*, VI. 72.

(5) *Astr. Nachr.*, XXIV. 138.

(6) *Astr. Nachr.*, XXIV. 254.

(7) *Am. Journal of Science*. Second Series, I. 293.

(8) *Astr. Journal*, IV. 3.

(9) *Astr. Journal*, Nos. 56, 57, 58, 60.

(10) *Astr. Journal*, No. 73.

(11) *Astr. Nachr.*, XXXII. 94.

(12) *Astr. Journal*, III. 90.

(13) *Astr. Journal*, IV. 4.

Greenwich M. T. Mean Equinox 1846.0.

ELEMENTS III. 2. Primary.

M. Feb. 11.0 0° 0' 3.668

Ω_0	327 3 54.70	Ω	245° 54' 15.25
ω_0	139 36 39.87	ω	223 8 37.64
i_0	21 27 10.31	i	12 31 52.76
q	49 10 15.03		
μ	537".36627		

ELEMENTS C. Secondary.

M' 359° 59' 19.068

Ω'_0	327 3 49.82	Ω'	245° 54' 17.00
ω'_0	139 36 46.65	ω'	223 8 37.36
i'_0	21 27 11.08	i'	12 31 54.62
q'	49 9 57.23		
μ'	537".53525		

§ 15.

Out of the great number of observations obtained at this appearance, and which are of various kinds and almost every degree of accuracy, I selected for future use all those made with a filar micrometer or heliometer, and for which the comparison-stars have been specially determined. These observations are of a high order of accuracy, and fortunately cover the whole period of visibility.

Since the above-mentioned results were obtained, I have been enabled to incorporate the Pulkowa determinations of the comparison-stars⁽¹⁾ with those previously adopted, and also to compute the solar coördinates from HANSEN'S Tables, instead of the Nautical Almanac. I have therefore made a new and independent comparison of the observed places with the elements just quoted, the result of which I now give by the side of the corrected observations.

I. PRIMARY NUCLEUS.⁽²⁾

Date.	Greenwich M. T.			C. — O.		Observatory.
				$\Delta\alpha$	$\Delta\delta$	
1845, Nov.	28.21535	336° 49' 3.9	+3° 40' 29.2	(−20.8)	(+45.8)	Berlin. ⁽³⁾
	29.24898	337 2 52.6	3 31 20.1	0.0	+ 7.6	Berlin. ⁽³⁾
Dec.	2.29067	337 48 45.3	3 4 5.7	+ 7.4	+ 2.9	Berlin. ⁽⁴⁾
	19.27400		1 9 4.0		−18.4	Cambridge (E.)
	19.27559	343 59 19.5		+ 1.5		Cambridge (E.)
	21.23359	344 54 5.1	0 58 59.9	− 3.2	− 3.9	Berlin.
	23.27086		0 49 12.7		+ 7.5	Greenwich.
	23.32054	345 54 54.9		+ 5.8		Cambridge (E.)
	23.33137		0 49 13.9		−10.2	Cambridge (E.)
	24.26479	346 23 25.0		+ 6.0		Greenwich.
	26.24166	347 25 16.6	0 36 27.7	−14.3	− 5.5	Geneva.
	27.26361	347 57 57.1	0 32 19.2	− 7.7	− 9.6	Geneva.
	29.23389	349 2 52.4	0 24 28.3	+ 3.0	− 6.5	Geneva.
	30.26134	349 37 51.8		− 0.4		Greenwich.
	30.26835	349 37 51.0		+14.8		Cambridge (E.)
	30.34138		0 20 11.3		− 2.8	Cambridge (E.)
	31.26845	350 12 47.5	0 16 56.8	− 2.4	−15.4	Geneva.
1846, Jan.	1.37455	350 51 44.7	+0 12 51.2	+ 4.8	−11.8	Cambridge (E.)
	12.52936	358 9 37.9	−0 26 5.7	+ 9.9	− 3.7	Washington.
	13.47844	358 50 43.8	0 29 31.6	+ 3.5	− 4.2	Washington.
	14.22928	359 23 43.2	0 32 17.3	− 4.7	− 4.8	Königsberg.
	14.49645	359 35 16.9	0 33 5.7	+ 8.4	−16.3	Washington.
	15.22666	0 7 56.4	0 36 7.2	− 3.6	− 0.5	Königsberg.
	15.28258	0 10 20.7	0 36 18.6	+ 1.0	− 1.9	Cambridge (E.)
	17.23369	1 38 57.2	0 44 1.0	− 4.4	+ 0.1	Königsberg.
	18.50673	2 38 3.6	0 49 23.6	− 1.4	+ 6.7	Washington.
	19.48593	3 24 3.6	0 53 28.6	+14.5	− 1.0	Washington.
	19.54646	3 27 6.9	0 53 47.6	+ 4.0	+ 2.1	Philadelphia.
	20.29004	4 2 48.3	0 57 6.3	− 0.5	+ 2.4	Greenwich.
	22.50317	5 51 10.3	−1 7 31.0	− 3.3	+ 0.8	Washington.

⁽¹⁾ *Astr. Journal*, Nos. 91, 92.⁽²⁾ From Circles of Equatorial (*A. N.*, XXIII. 380).⁽³⁾ *Astr. Journal*, Nos. 56, 57, 58.⁽⁴⁾ Same?

Date.	Greenwich M. T.	C. — O.				Observatory.
		α	δ	$\Delta\alpha$	$\Delta\delta$	
1846, Jan.	22.55895	5° 53' 53.1	—1° 7' 52.5	+ 0.4	+ 5.7	Philadelphia.
	23.28843	6 30 18.9	1 11 22.9	+ 4.9	— 3.6	Cambridge (E.)
	23.50222	6 41 8.5	1 12 27.4	+ 1.7	— 4.9	Washington.
	24.28964	7 21 2.0	1 16 35.8	+ 6.5	— 4.0	Cambridge (E.)
	24.51659	7 32 43.8	1 17 54.3	+ 0.9	+ 1.7	Washington.
	24.51787	7 32 49.1	1 17 57.3	— 0.4	+ 4.1	Philadelphia.
	26.22940	9 1 39.2	1 27 32.4	— 4.6	+ 5.0	Königsberg.
	26.49639	9 15 48.8	1 29 3.9	—11.4	+ 2.8	Washington.
	27.24986	9 55 36.0	1 33 33.9	— 2.3	+ 2.1	Königsberg.
	27.26247	9 56 12.0		+ 2.1		Cambridge (E.)
	27.26757		1 33 37.9		— 0.4	Cambridge (E.)
	27.30356	9 58 23.0		— 2.6		Berlin.
	27.30917		1 33 57.7		— 1.9	Berlin.
	28.24065	10 48 48.2	1 39 46.2	— 3.1	+ 3.8	Königsberg.
	28.25936	10 49 41.7	1 39 45.0	+ 4.1	— 4.6	Cambridge (E.)
	28.28759	10 51 6.9	1 40 1.5	+10.5	+ 1.1	Berlin.
	28.49059	11 2 16.6	1 41 24.5	+ 0.9	+ 5.9	Washington.
	28.50208	11 2 52.1	1 41 31.7	+ 2.7	+ 8.6	Philadelphia.
	29.24892	11 43 47.6	1 46 19.0	— 7.3	+ 1.5	Königsberg.
	29.29256	11 45 55.4	1 46 30.9	+ 8.6	— 4.2	Cambridge (E.)
	31.26561	13 35 56.1		+ 2.7		Greenwich.
	31.26737		2 0 24.7		— 2.2	Greenwich.
Feb.	3.29761	16 31 16.5	2 24 28.4	— 1.7	+ 5.9	Geneva.
	4.25975	17 28 38.4	2 32 45.7	— 5.6	+ 3.8	Berlin.
	5.28232	18 30 15.4	2 42 43.7	+ 6.9	(+46.6)	Geneva. ⁽¹⁾
	5.49456	18 43 20.2	2 43 40.8	— 0.7	—14.7	Washington.
	6.31581	19 33 48.6	2 51 44.0	+ 2.4	— 0.5	Berlin.
	7.29981	20 35 20.7		— 6.1		Greenwich.
	7.30292		3 1 42.7		+11.7	Greenwich.
	7.30233	20 35 14.9	3 1 40.5	+ 9.3	— 9.9	Berlin.
	9.28918	22 42 11.3		+ 8.7		Greenwich.
	9.29127		3 22 27.1		— 2.9	Greenwich.
	9.49538	22 55 29.5	3 24 47.1	+15.0	+ 1.8	Washington.
	10.27001	23 46 43.6	3 33 30.8	—12.8	+ 1.6	Geneva.
	11.28690	24 54 10.9	3 45 21.9	— 1.0	+ 0.2	Geneva.
	11.31810	24 56 5.1		+10.4		Cambridge (E.)
	11.32700		3 45 41.6		— 8.9	Cambridge (E.)
	11.54733	25 11 28.8	3 48 30.8	+11.8	+ 1.9	Washington.
	12.29714	26 2 43.2	3 57 33.5	—10.9	— 4.7	Geneva.
	12.30274		3 57 35.0		— 7.4	Cambridge (E.)
	12.49877	26 16 17.9	4 0 21.2	+ 1.5	+12.5	Washington.
	13.35085	27 15 2.0	4 10 52.1	+ 5.8	— 4.7	Cambridge (E.)
	13.51246	27 26 18.8	4 13 13.9	+ 4.1	+11.8	Washington.
	14.30053	28 21 51.8	4 23 34.5	— 8.4	+11.1	Königsberg.
	16.49886	31 0 12.6	4 53 55.7	+ 8.8	+ 6.5	Washington.
	17.28521	31 58 49.9	5 5 13.7	— 7.8	— 1.4	Geneva.
	18.25841	33 12 6.2	5 19 55.5	+ 2.2	+ 7.7	Berlin.
	18.28218	33 13 57.7	5 20 12.2	— 0.6	+ 2.7	Geneva.
	18.30735	33 15 53.1		— 0.9		Cape.
	18.31977		5 20 43.3		— 0.4	Cape.
	18.49904	33 30 37.1	5 23 35.0	— 0.4	+ 7.4	Washington.
	19.28101	34 30 50.3	5 35 30.3	— 0.4	— 2.4	Geneva.
	19.29805	34 32 12.6		— 3.2		Cape.
	19.30897		5 36 3.6		+ 4.7	Cape.
	20.28900	35 49° 55.0	5 51 32.1	+ 4.2	+ 0.7	Geneva.
	20.28440	35 49 39.4		— 2.1		Cape.
	20.29640		5 51 44.0		+ 5.5	Cape.
	21.52445	37 29 18.7	6 11 51.0	— 3.9	+ 8.5	Washington.
	22.28662	38 31 54.0	6 24 30.9	— 7.9	+ 2.1	Geneva.
	22.50391	38 49 42.1	6 28 16.7	+ 4.2	+ 6.9	Washington.
	24.35718	41 26 47.3	—7 0 16.3	+ 0.8	— 3.4	Cambridge (E.)

⁽¹⁾ Rejected by Plantamour.

Date.	Greenwich M. T.	α	δ	C. — O.		Observatory.
				$\Delta\alpha$	$\Delta\delta$	
1846, Feb.	25.30387	42° 49' 19.5"		+ 8.9		Cape.
	25.33374		—7° 18' 33.9"		(+16.4)	Cape. ⁽¹⁾
	25.32419	42 51 11.9		+ 4.0		Cambridge (E.)
	25.32491		7 17 38.3		+ 0.4	Cambridge (E.)
	26.28778	44 17 13.1	7 35 16.7	+ 0.8	+ 7.3	Berlin.
	26.30275	44 18 41.9	7 35 24.1	— 7.0	— 1.8	Geneva.
	26.30613	44 18 45.4		+ 7.8		Cape.
	26.32055		7 36 3.4		+17.9	Cape.
	26.51225	44 37 38.5	7 39 28.7	— 7.4	+11.7	Washington.
	27.27446	45 47 9.6	7 53 31.0	+ 0.8	+ 6.7	Berlin.
	27.36752	45 55 41.7	7 55 10.5	+ 3.8	+ 1.9	Cambridge (E.)
	28.29573	47 22 0.8		+21.5		Greenwich. ⁽¹⁾
	28.31280	47 24 1.8	8 13 0.2	— 3.0	+ 6.5	Cambridge (E.)
Mar.	1.35603	49 3 35.5		— 3.7		Cape.
	1.35607		8 32 40.8		— 3.2	Cape.
	2.30214	50 35 54.2	8 52 12.5	— 4.0	(—78.9)	Berlin.
	2.33682	50 39 14.7	8 51 34.0	+ 0.7	+ 0.2	Cambridge (E.)
	2.34058	50 39 25.7		+12.0		Greenwich.
	3.32257	52 17 37.0	9 10 36.0	— 1.3	— 1.7	Geneva.
	3.57823	52 43 21.0	9 15 44.1	+ 6.1	+ 8.6	Washington.
	4.33150	54 0 25.9	9 30 18.0	+ 3.3	+ 4.2	Berlin.
	4.33153	54 0 32.7	9 30 21.0	— 3.3	+ 7.1	Cape.
	4.58151	54 26 21.1	9 35 10.6	— 0.9	+ 4.8	Washington.
	5.31531	55 42 57.4	9 49 25.4	+ 3.8	+ 3.1	Cambridge (E.)
	5.33981	55 45 36.8		— 0.7		Greenwich.
	5.33985		9 49 47.7		— 3.3	Greenwich.
	5.35124	55 46 41.8	9 49 56.8	+ 6.6	— 7.4	Cape.
	5.55872	56 8 50.6	9 54 14.1	— 6.9	+ 7.8	Washington.
	6.35176	57 33 23.8		+ 1.1		Cape.
	6.35568		10 9 37.2		+ 2.5	Cape.
	7.29646		10 27 40.5		— 5.0	Cape.
	7.30219	59 16 52.8		— 5.6		Cape.
	7.32590	59 19 16.8	10 28 34.4	+ 6.7	+14.8	Berlin.
	8.35660	61 13 36.3	10 48 2.9	+14.9	— 0.7	Cape.
	8.55005	61 35 32.7	10 51 57.7	+ 3.4	+13.5	Washington.
	9.32007	63 2 56.9		+ 2.5		Cape.
	9.32911		11 6 22.3		— 3.4	Cape. ⁽³⁾
	10.29091	64 54 53.0	11 24 22.0	+ 7.8	+ 4.7	Berlin.
	10.31059	64 57 8.8		+ 9.6		Cambridge (E.)
	10.31072		11 24 41.7		+ 2.5	Cambridge (E.)
	10.31343	64 57 37.7	11 24 44.6	+ 0.5	+ 2.5	Cape.
	10.57380	65 27 59.0	11 29 37.5	+ 3.3	+ 9.2	Washington.
	11.26928	66 49 54.6	11 42 6.8	+ 1.6	+ 3.2	Königsberg.
	11.32497	66 56 26.7	11 43 4.5	+ 5.6	+ 1.0	Cape.
	12.32661	68 56 21.8	12 0 44.2	— 1.7	+ 0.8	Berlin.
	12.34069	68 58 0.5	12 1 4.2	+ 1.5	+ 6.1	Cape.
	13.31620	70 56 34.3	12 17 39.5	+ 2.2	+ 3.9	Cape.
	13.33464	70 58 54.1	12 18 4.4	— 2.0	+10.2	Geneva.
	14.32769	73 1 13.2	12 34 19.3	+10.4	+10.4	Cape.
	14.55510	73 29 40.6	12 37 53.4	+ 0.9	+ 7.3	Washington.
	15.32729	75 6 27.2		— 2.8		Cape.
	15.34090		12 49 48.1		— 8.6	Cape.
	16.33700	77 14 17.3	13 4 37.0	— 3.6	— 0.3	Geneva.
	17.32219	79 20 18.0	13 18 18.7	— 1.9	+ 5.1	Cape.
	17.57873	79 53 15.4	13 21 45.8	+ 1.3	+ 8.8	Washington.
	18.33198	81 30 34.0	13 31 12.8	+ 2.1	+ 3.0	Cape.
	19.29520	83 35 51.6	13 42 31.6	— 2.5	+ 2.1	Cape.
	20.30227	85 47 24.4	13 53 21.5	+ 1.6	+ 8.4	Cape.
	20.35276	85 54 2.0	—13 53 50.3	+ 1.0	+ 6.7	Berlin.

⁽¹⁾ Doubtless an error of 1 revolution = 44".53.⁽²⁾ 3 comparisons, which give, separately, +21".2 +36".0 +6".7.⁽³⁾ Declination of star in error 1'. Compare Weisse IV. 245.

Date.	Greenwich M. T.	α	δ	C. — O.		Observatory.
				$\Delta\alpha$	$\Delta\delta$	
1846, Mar.	20.37831	85° 57' 22.7	—13° 54' 2.3	+ 1.0	+ 2.3	Cambridge (E.)
	21.30711	87 59 17.9	14 2 45.6	— 4.5	+ 1.0	Berlin.
	21.31628	88 0 37.1	14 2 51.4	—11.5	+ 1.9	Geneva.
	21.32655	88 1 51.5	14 2 58.5	— 5.0	+ 3.5	Cape.
	21.57625	88 35 6.0	14 5 17.7	+ 7.6	+ 9.6	Washington.
	22.32509	90 13 3.7	14 11 6.4	— 6.6	— 2.7	Geneva.
	23.32629	92 24 18.9	14 18 19.6	+ 7.0	+ 8.8	Cape.
	23.33372	92 25 14.9	14 18 12.0	+ 9.6	— 1.6	Greenwich.
	24.32411		14 14 1.1		+ 4.4	Greenwich.
	24.33545	94 36 36.9		+ 1.8		Cambridge (E.)
	24.34702		14 24 4.6		+ 0.8	Cambridge (E.)
	24.34723	94 38 8.5	14 24 2.6	+ 2.8	— 1.2	Cape.
	25.32224	96 45 16.4		+ 6.0		Cambridge (E.)
	25.33389		14 28 33.4		+ 2.0	Cambridge (E.)
	26.32140	98 51 46.4		+ 8.2		Cape.
	27.32588	101 4 14.2		—10.0		Cape.
	27.34592		14 33 53.2		— 3.7	Cape.
	27.35058	101 6 40.9		+33.1		Greenwich. ⁽¹⁾
	27.35074		14 33 58.0		+ 0.6	Greenwich.
	27.36198		14 33 39.2		—19.1	Cambridge (E.)
	27.38670	101 11 23.7		+27.6		Cambridge (E.)
	28.33321	103 12 14.3		+ 3.5		Cape.
	28.33716		14 34 49.4		— 2.8	Cape.
	29.31850	105 15 59.2	14 34 40.3	+15.3	— 1.8	Cape.
	29.34273		14 34 38.3		— 2.8	Cambridge (E.)
	29.34694	105 15 54.1		— 6.3		Cambridge (E.)
	29.36309		14 34 37.9		— 2.2	Greenwich.
	29.36510	105 22 24.5		—20.9		Greenwich.
	30.32846	107 21 51.3	14 33 30.6	—17.3	+ 3.2	Geneva.
	30.63989	107 59 38.0	14 33 3.5	+11.9	+12.0	Washington.
	31.34750	109 26 10.5		— 6.1		Cape.
	31.35741		14 31 0.2		— 7.6	Cape.
	31.64012	110 1 29.8	14 30 36.4	— 3.5	+17.7	Washington.
April	1.38447	111 30 51.9	14 28 4.8	—16.8	+15.6	Berlin.
	1.39678		14 28 5.8		+19.2	Cambridge (E.)
	1.40436	111 32 46.4		+10.5		Cambridge.
	2.32077	113 21 3.2		— 4.1		Cape.
	2.33819		14 23 46.0		— 9.6	Cape.
	3.28646		14 19 21.0		+ 1.1	Cape.
	3.29337	115 13 44.9		—13.5		Cape.
	3.62067	115 50 49.8	14 17 43.2	+ 3.5	+10.1	Washington.
	13.36803	132 18 16.8		—15.5		Cambridge (E.)
	13.37540		13 1 33.7		—27.1	Cambridge (E.)
	15.57578	135 27 41.7	12 41 40.0	+18.3	—19.8	Washington.
	19.64467	140 48 10.4	12 4 53.0	+28.4	—26.8	Washington.
	24.42941	146 22 26.2	—11 24 44.3	—16.1	—18.6	Berlin.

⁽¹⁾ 3 comparisons, which give, separately, +27".7 +56".8 +14".7.

(To be continued.)

ECLIPSE OF 1860, JULY 18.

THE cloudless sky which prevailed at the time of the eclipse over all parts of the continent from which accounts have yet been received, has occasioned a confident hope that the astronomical parties along the path of total obscuration, in Labrador, at Cumberland House, near Lake Winnipeg, and in Washington Territory, may have been equally fortunate; and that important and instructive observations may soon be expected from them.

The following observations have already been communicated to the Editor of this Journal.

A. AT FREDERICTON, NEW BRUNSWICK.

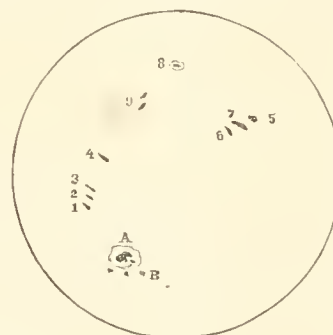
At the Observatory of the University of New Brunswick, in Latitude $45^{\circ} 56' 53''$ N., and Longitude $4^{\text{h}} 26^{\text{m}} 33^{\text{s}}$ W., the following observations were made on the Solar Eclipse of 1860, July 18, with an equatorial refractor of $7\frac{1}{2}$ feet focal length, the aperture being contracted to 3 inches, and the power employed being 96.

As the eclipse advanced, the flocculi, or curdled appearances on the disc of the sun, became very apparent, especially on the upper edge (as seen through the telescope), where the cloudy appearances seemed to accumulate round the dark lines of fore-shortened solar spots. The disc of the moon was remarkable for its inky blackness, but nothing otherwise peculiar was observed upon it. At the commencement of the eclipse the thermometer stood at $60^{\circ}.5$ Fahr. : at the greatest obscuration it fell to 57° , though part of this effect may be attributed to a somewhat dense cloud, which then partially covered the face of the sun. At the end of the eclipse the thermometer had risen to 67° . The barometer appeared to be unaffected, standing steadily at 30.022.

I may mention that some of the students of the University had previously calculated the times of first and last contact, finding them to be $7^{\text{h}} 44^{\text{m}} 50^{\text{s}}$ and $9^{\text{h}} 59^{\text{m}} 48^{\text{s}}$ A. M., mean time. Had HANSEN'S tables been used as the basis of their calculations, instead of BURCKHARDT'S, which are employed in the construction of the English Nautical Almanac, I believe that the calculated times would have agreed yet more closely with those actually observed, which, in mean time, are $7^{\text{h}} 46^{\text{m}} 14^{\text{s}}$ and $10^{\text{h}} 0^{\text{m}} 52^{\text{s}}$ for first and last contact respectively.

The accompanying rough diagram will serve to indicate the

situation of the spots, as seen through the inverting telescope, and may facilitate their recognition by other observers.



Sidereal Time.			
h	m	s	
At 3 32 20			the first contact was observed.
3 46 24			Contact with nucleus of spot <i>B</i> .
3 47 0			Contact with umbra of large spot <i>A</i> .
3 47 44			Contact with nucleus of large spot <i>A</i> .
4 24 0			Spots 1, 2, 3, 6, 5, all very near the edge of the moon, which, however, did not appear to approach nearer to spots 1, 2, 3.
4 25 15			Contact with spot 5.
4 25 49			Contact with nucleus of spot 6.
4 27 27			Contact with nucleus of spot 7.
5 4 0			Approach to spot 8 nearly equal to that made to 1, 2, 3.
5 29 15			Reappearance of spot 7.
5 33 56			Reappearance of spot 5.
5 47 20			Last contact was observed.

W. BRYDONE JACK.

B. AT NEW HAVEN, CONN.

[Communicated by Professor HUBBARD.]

THE solar eclipse of 1860, July 18, was observed at New Haven, as follows : —

1. By Professor LYMAN, at his private observatory, $28''.3$ E. and $20''.0$ N. of the College Atheneum, with an achromatic telescope by BANKS, $2\frac{1}{4}$ inches aperture and 28 inches focus.

2. By Professor HUBBARD, at the Atheneum, in longitude $72^{\circ} 55' 25''.2$, latitude $41^{\circ} 18' 22''.4$, with the Clark telescope, 5 inches aperture and 10 feet focus.

In consequence of the unfortunate location of this excellent instrument, in a tower whose windows limit the range of the telescope to a low zone of the heavens, it was impossible to obtain here a complete observation of the eclipse, and resort was had,

3. to the house of STILES FRENCH, Esq., $24''.5$ E. and $4''.5$ N. of the Atheneum, where the end was observed with a Gregorian reflector, 4.4 inches aperture, and about 26 inches focus.

Besides the times of beginning and end of eclipse, the occultations of several spots were also noticed, and may be useful by comparison with observations elsewhere obtained, or absolutely, in case the position of the spots shall have been determined at the time.

	New Haven M. T. (Station 1)					
	1 (L.)			2 (H.)		3 (H.)
	^h	^m	^s	^m	^s	
Beginning of eclipse	19	15	27.5	15	21.1	
<i>Immersion.</i>						
Small spot (<i>a</i>), 1st cont.	32	1.7		32	3.2	
2d "				32	19.2	
Large spot (<i>b</i>), 1st "	34	20.2		34	12.2	
Bright point 1st "	34	48.3				
2d "	35	7.2		35	9.2	
Dbl. spot (<i>c.1</i>), 1st "	20	9	41.5	9	37.2	
2d "				10	6.2	
(<i>c.2</i>), 1st "				9	37.2	
2d "	10	13.5		10	15.7	
Spot (<i>d</i>), 1st "	13	15.0		13	17.2	
2d "	13	29.0		13	30.7	
<i>Emersion.</i>						
Large spot (<i>b</i>), 1st "				15	13.2	
2d "				16	16.2	
Small spot (<i>a</i>), 2d "	52	54.5				
End of eclipse	21	18	18.3			18 8.2

C. AT NEW YORK CITY.

THE eclipse of July 18 was carefully observed at New York University. The weather was uncommonly favorable, and the observations highly satisfactory. The contacts were observed by myself, and the time furnished by Professor R. H. BULL. The following are the results, expressed in mean time at the University:—

Beginning,	^h 7 ^m 10 ^s 23.31
End,	9 11 11.05
Duration,	2 0 47.74

New York University, 1860, July 19.

ELIAS LOOMIS.

D. AT CAMBRIDGE.

[From a report to Professor BACHE, Superintendent U. S. C. S.]

The eclipse was observed very satisfactorily at the Cloverden station of the Coast Survey. All the observations were made by Mr. SEARLE, except the beginning, which was observed by me. The telescope has an aperture of 4.6 inches, and a magnifying power of about 80 times was employed. The error and rate of the chronometer were thoroughly determined by a series of transit-observations on several successive nights, before and after the eclipse; so that no error except that of the observers' perception, need be apprehended.

	Cloverden S. T. ^h ^m ^s	M. T. ^h ^m ^s
Beginning of eclipse	3 10 14	19 24 1
Spot B, 1st contact	3 26 22	19 40 6
Spot A, "	3 28 7	19 41 5
Center of large spot, 1st contact	3 28 36	19 42 20

Cambridge, 1860, July 23.

	Cloverden S. T. ^h ^m ^s	M. T. ^h ^m ^s
Double spot C (together), 1st cont.	4 4 20	20 17 58
Spot D, 1st contact	4 7 4	20 20 42
Large spot. Complete emersion of black portion	4 14 1	20 27 37
Spot B, 2d contact	4 15 42	20 29 18
Spot D, "	4 53 13	21 6 43
Double spot C, (I.), 2d contact	5 1 51	21 15 20
(II.) "	5 2 17	21 15 45
End of eclipse	5 16 37	21 30 3

The observations were in sidereal time, and the limit of probable error of observation is estimated, both by Mr. SEARLE and by me, as not exceeding three seconds.

B. A. GOULD.

E. AT WEST HAVERFORD, PA.

Haverford Observatory, 1860, 7 mo. 18th.

THE following times for beginning and end of the eclipse of this date, as observed at the Haverford College Observatory, I think may be relied upon as not differing more than half a second from the true result. The instrument used was an equatorial telescope of 11 feet focal distance, with a magnifying power of 100, attached to a position-micrometer. The moon entered upon the sun at the exact point that calculation gave.

I will give the results of my computation, as well as those

of observations. The computation was made for Long. 5^h 1^m 13^s and Lat. 40° 0' 36".

RESULTS.

	Haverford Mean Time.	
	Observed. ^h ^m ^s	Computed. ^h ^m ^s
Beginning of eclipse	19 4 12.02	19 3 59.99
End	21 2 28.77	21 2 16.40
Duration	1 58 16.75	1 58 16.41

M. C. STEVENS.

CORRIGENDUM.

No. 136, page 128, in both sets of elements, for 9^m.46 read 9.46.

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CORRIGENDUM.

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CAMBRIDGE, 1860, AUGUST 15.

NO. 18.

ON BIELA'S COMET.

By PROFESSOR J. S. HUBBARD

OF THE WASHINGTON OBSERVATORY.

II. — (*Concluded.*)

§ 15.

FROM these observations I have deduced the following normals, of which the first and last are only retained for comparison;—the one depending only on two “instrumental” positions, and the other upon four observations, obtained with great difficulty, and liable to more than usual uncertainty.

	Greenwich M. T.	C. — O.		α	δ	No. of Observations.	
		$\Delta\alpha$	$\Delta\delta$			α	δ
	1845, Dec. 1.0	+3.7	+ 5.2	337° 28' 30.9	+ 3° 15' 22.9	2	2
XII.	27.0	+0.7	— 7.7	347 49 17.5	+ 0 33 21.8	11	10
XIII.	1846, Jan. 16.0	+2.4	— 1.9	0 42 34.2	— 0 39 4.8	11	11
XIV.	24.0	—0.2	+ 0.6	7 6 23.3	1 15 8.3	12	12
XV.	Feb. 5.0	+1.9	+ 0.4	18 13 10.5	2 39 21.6	18	17
XVI.	17.0	+0.3	+ 2.2	31 37 26.0	5 1 6.6	16	17
XVII.	25.0	+1.3	+ 4.5	42 22 43.8	7 11 51.7	17	15
XVIII.	Mar. 5.0	+2.1	+ 2.8	55 9 53.2	9 43 17.1	18	16
XIX.	13.0	+2.0	+ 4.2	70 17 56.6	12 12 20.5	16	16
XX.	21.0	+0.3	+ 3.1	87 18 54.3	14 0 0.7	14	15
XXI.	29.0	+1.2	+ 1.9	104 36 19.7	14 34 54.2	18	17
	Apr. 18.0	+3.8	—23.1	138 13 22.9	—12 19 36.3	4	4

2. SECONDARY NUCLEUS.

Assuming that the observations obtained by CHALLIS, on the 1st and 3d of December, refer to the secondary nucleus, upon which point, however, I am not now in a condition to insist particularly, I find

Cambridge (England).

Date.	Greenwich M. T.	α'	δ'	C. — O.	
				$\Delta\alpha'$	$\Delta\delta'$
1845, Dec.	1.28236		+3° 13' 20.1		—35.8
	.28755	337° 32' 5.9		+0.7	
	3.30658	338 4 51.2		—4.1	
	.32273		+2 55 47.1		—34.8

I may remark that it is only upon this hypothesis that the right-ascensions appear probable,—the declinations are discrepant in both.⁽¹⁾ I have, however, made no further use of these observations.

Computing now the places of this nucleus for each fourth

day from the elements given above, and subtracting from the results the corresponding tabular positions of the primary, we have an ephemeris of $\alpha' - \alpha$ and $\delta' - \delta$, which, compared with the differential measures, furnishes the values $\Delta(\alpha' - \alpha)$ and $\Delta(\delta' - \delta)$, from which the $\Delta\alpha$ and $\Delta\delta$ are subsequently eliminated in the formation of normals.

⁽¹⁾ See *Astr. Journal*, IV. 3.

DIFFERENTIAL MEASURES.⁽¹⁾

Date.	Greenwich M. T.	$\alpha' - \alpha$	$\delta' - \delta$	$\Delta(\alpha' - \alpha)$	$\Delta(\delta' - \delta)$	Place of Observation.
1846, Jan.	14.50	— 60.0	+ 69.1	— 7.8	+ 16.0	Washington.
	18.52	66.9	108.2	— 4.8	— 7.2	Washington.
	19.49	61.9	106.3	— 7.8	— 1.0	Washington.
	22.51	82.5	113.6	+ 6.4	+ 5.6	Washington.
	22.54	70.7	126.9	— 5.4	— 7.7	Philadelphia.
	23.30	77.7	123.3	+ 0.6	— 0.2	Cambridge (E.)
	.52	77.1	120.8	— 0.3	+ 3.4	Washington.
	24.29	76.6	127.3	— 1.8	+ 0.9	Cambridge (E.)
	.52	82.3	123.9	+ 3.6	+ 5.5	Washington.
	.52	78.1	130.8	— 0.6	— 1.4	Philadelphia.
	26.21	81.9	137.7	+ 1.0	+ 0.8	Königsberg.
	.50	82.2	140.7	+ 0.9	— 0.7	Washington.
	27.26	83.9	143.0	+ 1.5	+ 1.3	Königsberg.
	.27	87.6	145.4	+ 5.2	— 1.1	Cambridge (E.)
	.31	85.0	146.6	+ 2.6	— 2.1	Berlin.
	28.26	84.0	146.6	+ 0.2	+ 3.5	Berlin.
	.26	86.5	151.9	+ 2.7	— 1.8	Cambridge (E.)
	.49	89.9	153.5	+ 5.8	— 2.0	Philadelphia.
	.50	84.7	147.3	+ 0.6	+ 4.2	Washington.
	29.31	81.6	155.3	— 3.8	+ 1.1	Cambridge (E.)
	30.24	87.0	160.8	+ 0.1	+ 1.2	Berlin.
Feb.	2.28	91.8	182.2	— 0.4	— 0.2	Berlin.
	4.25	98.0	195.4	+ 1.5	+ 0.5	Berlin.
	.49	93.7	191.0	— 3.3	+ 6.7	Washington.
	.54	101.7	206.7	+ 4.7	— 8.7	Philadelphia.
	5.29	97.5	180.0	— 1.4	(+23.7)	Geneva. ⁽²⁾
	.51	97.9	202.3	— 1.5	+ 3.0	Washington.
	6.29	105.1	210.0	+ 3.6	+ 1.2	Berlin.
	.32	108.6	212.3	+ 7.1	— 0.9	Paris.
	7.29	102.1	217.4	— 2.2	+ 1.6	Berlin.
	.31	107.5	221.1	+ 3.2	— 2.0	Greenwich.
	8.31	108.9	236.4	+ 1.6	— 9.3	London.
	9.	86.0	233.0	(—24.4)	+ 2.1	Königsberg.
	.29	110.0	229.1	— 0.4	+ 6.0	Greenwich.
	.50	111.6	242.4	+ 0.5	— 5.5	Washington.
	10.27	112.5	247.3	— 1.1	— 3.9	Geneva.
	.27	113.5	245.0	— 0.1	— 1.6	Berlin.
	.30	104.0	237.5	— 9.7	+ 6.2	Paris.
	11.31	112.6	250.3	— 4.6	+ 2.2	Cambridge (E.)
	.54	115.8	244.6	— 2.2	+ 10.0	Washington.
	12.29	123.0	260.4	+ 2.0	+ 0.9	Paris.
	.30	118.3	253.9	— 2.7	+ 7.5	Cambridge (E.)
	.30	122.7	258.8	+ 1.7	+ 2.6	Geneva.
	.51	119.9	270.6	— 1.9	— 7.3	Washington.
	13.20	126.7	271.5	+ 2.1	— 1.9	Dorpat.
	.31	124.9	266.1	— 0.2	+ 4.5	Cambridge (E.)
	.52	130.0	278.4	+ 4.0	— 5.8	Washington.
	14.29	133.9	279.3	+ 4.3	+ 0.4	Berlin.
	.30	134.6	281.8	+ 5.0	— 2.0	Königsberg.
	15.23	137.0	295.8	+ 2.6	— 7.3	Dorpat.
	16.26	144.3	313.2	+ 4.5	— 14.9	Dorpat.
	.52	144.1	305.4	+ 2.8	— 4.5	Washington.
	17.29	144.6	303.2	— 1.1	+ 5.3	Geneva.
	18.29	149.7	318.1	— 2.2	+ 0.5	Geneva.
	.32	158.4	319.4	+ 6.4	— 0.5	Cape.
	.32	143.9	316.3	— 8.1	+ 2.6	Berlin.
	.53	149.7	317.9	— 3.7	+ 3.1	Washington.
	19.23	158.5	331.4	+ 0.4	— 3.2	Pulkowa.
	.28	— 151.6	+ 322.9	— 6.9	+ 5.8	Geneva.

⁽¹⁾ *Astr. Journal*, N^o. 60.⁽²⁾ Single comparison.

Date.	Greenwich M. T.	$\alpha' - \alpha$	$\delta' - \delta$	$\Delta(\alpha' - \alpha)$	$\Delta(\delta' - \delta)$	Place of Observation.
1846, Feb.	19.31	-164.2	+333.1	+ 5.5	- 4.1	Cape.
	20.29	165.0	331.0	- 0.8	+ 5.2	Geneva.
	.29	163.8	342.0	- 2.0	- 2.8	Cape.
	.30	158.6	351.2	- 7.2	-11.9	Königsberg.
	21.25	177.6	351.1	+ 4.5	- 1.8	Pulkowa.
	.52	176.4	354.5	+ 1.1	- 2.3	Washington.
	22.29	183.3	360.6	+ 1.6	- 0.2	Geneva.
	.51	181.8	364.5	- 1.7	- 1.8	Washington.
	.55	191.4	353.1	+ 7.5	+10.0	Philadelphia.
	24.31	165.0		(-35.7)		Greenwich.
	.35	203.9	380.7	+ 3.1	+ 1.7	Cambridge (E.)
	25.30	209.9	391.4	- 0.7	+ 1.2	Cambridge (E.)
	.32	232.3	435.0	(-21.5)	(-42.1)	Cape. ⁽¹⁾
	26.28	220.7	402.1	- 0.9	+ 1.1	Berlin.
	.31	219.4	395.3	- 2.5	+ 8.2	Geneva.
	.54	222.6	410.1	- 2.0	- 4.1	Washington.
	27.28	232.1	416.1	- 1.2	- 2.1	Berlin.
	.33	229.5	415.1	- 4.4	- 0.5	Cambridge (E.)
	28.30	250.0		+ 3.9		Greenwich.
	.31	250.8	427.9	+ 4.6	- 2.9	Cambridge (E.)
Mar.	2.27	264.6	447.8	- 8.8	- 2.1	Berlin.
	.34	270.0		- 4.5		Greenwich.
	.34	276.0	445.2	+ 1.5	+ 1.2	Cambridge (E.)
	3.32	273.6	456.5	-15.6	- 0.1	Geneva.
	.58	292.1	446.2	- 1.1	+12.8	Washington.
	4.23	308.8	470.9	+ 5.3	- 5.5	Pulkowa.
	.29	302.2	466.4	- 2.3	- 0.4	Berlin.
	.59	309.9	491.9	+ 0.5	(-22.9)	Washington. ⁽²⁾
	5.	319.7	461.8	- 1.6	+14.1	Königsberg.
	.32	319.3	476.2	- 2.3	- 0.3	Cambridge (E.)
	.33	315.0		- 6.8		Greenwich.
	.57	337.5	488.0	+11.6	- 9.7	Washington.
	7.31	368.8	506.7	+11.8	-12.9	Berlin.
	8.56	378.7		- 1.7		Washington.
	10.56	408.9		-10.9		Washington.
	14.57	493.5	550.9	- 9.4	-14.4	Washington.
	16.34	534.6	526.4	- 5.0	+13.0	Geneva.
	19.31	593.5	512.3	- 3.9	- 6.0	Geneva.
	20.30	622.9	533.8	+ 7.8	- 0.8	Berlin.
	.37	617.9	548.0	+ 1.5	-15.3	Cambridge (E.)
	21.32	629.6	522.9	- 2.6	+ 5.7	Geneva.
	.58	646.5	525.3	+10.1	+ 2.0	Washington.
	22.33	646.8	504.9	- 1.1	+18.1	Geneva.
	23.27	643.6	519.8	-17.7	- 2.8	Pulkowa. ⁽³⁾
	24.27	677.0	508.5	+ 2.8	+ 1.1	Pulkowa.
	25.37	693.9	507.1	+ 7.3	- 6.5	Cambridge (E.)
	27.38	-710.5	+482.4	+ 6.0	- 0.9	Cambridge (E.)

Hence we obtain the subjoined normal results for the secondary nucleus.

	Date.	Greenwich M. T.	C. - O.		$\alpha' - \alpha$	$\delta' - \delta$	α'	δ	C. - O.		No. of Obs.	
			$\Delta(\alpha' - \alpha)$	$\Delta(\delta' - \delta)$					$\Delta\alpha'$	$\Delta\delta'$	α	δ
1	1846,											
2	Jan.	24.0	-0.4	+0.8	- 77.6	+125.9	7 5 5.7	- 1 13 2.4	-0.6	+1.4	15	15
3	Feb.	5.0	0.0	+0.6	98.2	200.9	18 11 32.3	2 36 0.7	+1.9	+1.0	24	24
4		17.0	+0.4	-1.3	144.4	306.9	31 35 1.6	4 55 59.7	+0.7	+0.9	25	25
5		25.0	+0.6	+1.0	208.0	388.4	42 19 15.8	7 5 23.3	+1.9	+5.5	12	11
6	Mar.	5.0	-1.7	-0.3	314.5	473.2	55 4 38.7	9 35 23.9	+0.4	+2.5	15	10
		21.0	-0.3	-0.6	-626.7	+530.7	87 8 27.6	-13 51 10.0	0.0	+2.5	12	12

(¹) Error of 1 revolution in δ of primary?

(²) Single comparison in δ .

(³) Refractor used as equatorial.

§ 16. SIXTH APPEARANCE, 1852.

As the time drew near for the return of the two comets to their perihelion in 1852, and the attention of astronomers began to be again directed to the subject, great interest was manifested relative to the phenomena that might be presented. Had the two companions pursued their journey in harmony, returning as they went, without apparent mutual interference, or should we find them moving in new and diverse paths?

SANTINI, who had already, with so much skill and success, followed the original comet in all its perturbations since 1826, had now extended his calculations over the present period also, and found that the time of perihelion-passage given by the ellipse of 1846 would be delayed some five days by the action of disturbing forces, and that the perihelion, occurring in September, the comets would be so remote from the earth and so nearly in the direction of the sun as to afford but little hope that they would be visible.

One of the nuclei, the southern and following of the two, as afterwards appeared, was found by SECCHI, at Rome, on the 25th of August, and observed by him also on the 27th, 28th, and the 1st of September, on neither of which dates could he perceive the slightest trace of the companion. CHALLIS found the same one, still alone, on the 8th of September. At length, on the 15th SECCHI found both nuclei, and determined the position of one of them, the other "new one" being too faint for observation. But it appears upon comparison, that the new one is the same that he had been already observing since August, and that the brighter was now visible for the first time. On the 16th the southern nucleus alone was visible, on the 17th and 18th only the northern, and finally, on the 19th,

both were observed by SECCHI, and the double observation was repeated at Rome and at Pulkowa on the 20th, 23d. and 25th, while on the 21st only the southern, and on the 22d only the northern one was visible.

These remarkable alternations were strikingly manifested when both comets were visible at the same time, and are perfectly illustrated by OTTO STRUVE's beautiful drawings,⁽¹⁾ which represent the appearance and relative position of the comets on the 20th and 25th of September. Upon each of these nights one nucleus was small, perfectly round, and tailless, while the other was larger, oval-shaped, and with a tail of about 1' in length: but the interchange of appearance from one nucleus to the other is as complete as if the two representations had been taken from the same plate, reversed between the printings, except that the direction of the tail is the same in both cases, in the one pointing towards, in the other directly from, the other nucleus.

We thus have a most interesting repetition of the alternations exhibited in 1845-46, which now appear more remarkable only in consequence of the extreme faintness of the comets, which was such that the slightest change of light sufficed to carry them either within or beyond the reach of vision.

§ 17.

The elements used in reducing the few observations obtained at this time are the following, deduced from the above-mentioned Elements III. and B for 1846, by applying SANTINI's perturbations, and assuming $\Delta\mu = +0''.33355$ and $\Delta\mu' = +0''.26551$.

Greenwich M.T. Mean Equinox 1852.0.

ELEMENTS III. 1. North Preceding Nucleus.

M. Sept. 23.0	359° 53' 30".18		
Ω_0	327 8 2.3	Ω	245° 51' 25".8
ω_0	139 38 18.1	ω	223 16 51.0
i_0	21 26 20.9	i	12 33 16.1
q	49 6 21.48		
μ	535".91653		

ELEMENTS B. 1. South Following Nucleus.

M'	359° 59' 29".62		
Ω'_0	327 7 55.9	Ω'	245° 51' 28".4
ω'_0	139 38 22.6	ω'	223 16 47.5
i'_0	21 26 21.9	i'	12 33 19.0
q'	49 6 3.95		
μ'	536".08439		

§ 18. OBSERVATIONS AND NORMALS.

1. Preceding Nucleus.⁽²⁾

Date.	Greenwich M. T.	α	δ	C. — O.		Place of Observation.
				$\Delta\alpha$	$\Delta\delta$	
1852, Sept.	15.63330	139° 7' 50".5	+11° 56' 7".5	—17".7	+11".8	Rome.
	17.61078	141 32 1.3	10 51 0.3	+ 4.0	+10.1	Berlin.
	18.55524	142 40 30.2	10 19 47.0	— 4.2	+ 5.3	Pulkowa.
	19.62621	143 57 22.5	9 43 45.8	+ 0.9	+30.3	Rome.
	20.57088	145 4 49.3	9 12 44.7	— 1.9	+ 3.1	Pulkowa.
	.63172	145 8 56.9	9 10 19.8	+10.0	+26.4	Rome.
	22.62528	147 29 57.6	8 4 17.0	— 9.3	— 2.2	Berlin.
	23.58304	148 36 49.0	7 32 17.7	— 8.2	— 0.6	Pulkowa.
	25.57127	150 54 4.2	6 25 56.8	— 2.8	+ 5.7	Pulkowa.
	28.58623	151 18 27.2	+ 4 46 5.3	+ 2.6	+ 7.2	Pulkowa.

⁽¹⁾ Beob. des Biela'schen Cometen, im Jahre 1852.

⁽²⁾ Astr. Journal, N^o. 73.

The Roman declinations were obtained with a ring or reticular micrometer, and may fairly be omitted in this connection; we then have for this nucleus the following normal:—

Date.	Greenwich M. T.	C. — O.		α	δ	No. of Observations	
		$\Delta\alpha$	$\Delta\delta$			α	δ
1852, Sept. 21		—2 ^h .7	+4 ^h .1	145° 35' 18 ^h .1	+8° 58' 25 ^h .0	10	7

2. Following Nucleus.⁽¹⁾

Date.	Greenwich M. T.	α	δ	C. — O.		Place of Observation.
				$\Delta\alpha$	$\Delta\delta$	
1852, Aug. 25.61814		112° 22' 30 ^h .7	+21° 47' 38 ^h .1	—38 ^h .4	+2 ^h .6	Rome. ⁽²⁾
.63348		112 23 28.5	21 46 55.9	—21.4	+23.6	Rome.
27.61412		115 3 54.1	20 59 50.2	—40.1	+41.6	Rome.
28.63454		116 25 49.5	20 35 22.3	—24.3	—0.8	Rome.
Sept. 1.63125		121 45 23.2	18 49 51.2	—25.8	+21.4	Rome.
8.65876		130 54 6.4	15 24 35.2	—70.5	—5.6	Cambridge (E.)
16.65995		140 51 39.0	11 8 4.9	—43.6	+9.3	Cambridge (E.)
19.63211		144 25 27.4	9 29 35.3	—20.1	+22.3	Rome.
20.57723		145 32 44.1	8 58 22.5	—26.2	+11.2	Pulkowa.
.64100		145 37 5.2	8 56 17.4	—16.3	+9.1	Rome.
21.66099		146 48 53.8	8 22 17.7	—7.4	+13.6	Cambridge (E.)
.66745		146 49 35.0	8 21 58.6	—21.3	+19.7	Cambridge (E.)
23.57073		149 2 30.5	7 18 52.6	—25.4	+8.2	Pulkowa.
25.58399		151 20 59.9	+6 11 55.1	—22.8	+17.9	Pulkowa.

For this nucleus we have two normals, the first of which is based upon the earlier observations at Rome, and the second upon the observations of the 16th and subsequent days, excluding, as before, the Roman declinations from combination with the others.

Date.	Greenwich M. T.	C. — O.		α	δ	No. of Observations.	
		$\Delta\alpha$	$\Delta\delta$			α	δ
1852, Aug. 28		—30.0	+17.7	115° 34' 50 ^h .5	+20° 50' 47 ^h .9	5	5
Sept. 21		—22.9	+13.3	146 2 34.7	+8 44 16.9	8	6

§ 19. RECAPITULATION.

Normal Observations of the Comet, and Solar Coördinates from HANSEN'S Tables.

(Apparent Equinox of date.)

	Date. Greenwich M. T.	α	δ	No. of Obs.		$\odot$	Log R	B	ε
				α	δ				
I.	1772 Mar. 30.0	95° 14' 18 ^h .6	—7° 39' 12 ^h .7	4	4	10° 20' 3 ^h .4	0.0000414	+ ^h .63	23° 27' 60 ^h .22
II.	1805 Nov. 18.0	13 29 30.6	+38 13 44.7	19	12	235 45 50.7	9.9946453	— ^h .74	53.46
III.	Dec. 2.0	4 59 21.1	+19 41 46.3	8	8	249 56 41.3	.9935629	+ ^h .34	53.13
IV.	6.0	359 15 44.6	—1 15 56.3	6	4	254 0 25.5	.9933229	.00	53.04
V.	8.25	353 10 15.3	—23 26 17.0	4	3	256 17 36.3	9.9932063	— ^h .33	52.99
VI.	1826 Mar. 12.0	40 46 31.8	+10 21 27.8	24	23	351 25 13.0	9.9975900	+ ^h .40	39.46
VII.	Apr. 5.0	71 6 2.0	10 33 54.6	56	53	15 10 24.1	0.0005667	+ ^h .65	39.21
VIII.	May 3.0	110 12 57.3	+6 33 37.6	14	13	42 29 3.3	0.0038360	+ ^h .61	38 54
IX.	1832 Sept. 24.0	85 34 37.3	+36 15 17.7	2	2	181 25 2.6	0.0009952	+ ^h .66	35.42
X.	Oct. 27.0	142 26 30.1	+15 39 53.6	12	12	214 6 3.7	9.9969375	+ ^h .60	35 29
XI.	Nov. 24.0	178 37 18.1	—10 28 25.5	10	10	242 16 41.3	.9911765	+ ^h .50	31.96
	Dec. 26.0	207 31 34.3	—25 40 24.7	13	13	274 48 41.7	9.9926936	— ^h .21	34.95

⁽¹⁾ *Astr. Journal*, N^o 73.

⁽²⁾ Coincidence observation.

	Date.	α	δ	N. of Obs.		$\odot$	Log R	B	ε
	Greenwich M. T.			α	δ				
	1845-46.								
	Dec. 1.0	337° 28' 30".9	+ 3° 15' 22".9	2	2	219° 13' 26".8	9.9936948	+ ".37	23° 27' 26".37
XII.	27.0	347 49 17.5	+ 0 33 21.8	11	10	275 40 41.6	.9926937	+ .19	26.07
XIII.	Jan. 16.0	0 42 34.2	- 0 39 4.8	11	11	296 3 31.3	.9929200	- .69	26.11
XIV.	24.0	7 6 23.3	1 15 8.3	12	12	304 11 52.4	.9932858	+ .22	26.19
XV.	Feb. 5.0	18 13 10.5	2 39 21.6	18	17	316 22 42.8	.9940314	- .45	26.33
XVI.	17.0	31 37 26.0	5 1 6.6	16	17	328 30 10.6	.9950518	- .17	26.47
XVII.	25.0	42 22 43.8	7 11 51.7	17	15	336 33 19.8	.9958670	+ .34	26.53
XVIII.	Mar. 5.0	55 9 53.2	9 43 17.1	18	16	344 34 38.6	.9967289	- .55	26.58
XIX.	13.0	70 17 56.6	12 12 20.5	16	16	352 33 42.5	.9976502	- .61	26.58
XX.	21.0	87 18 54.3	14 0 0.7	14	15	0 30 42.5	.9986419	+ .27	26.55
XXI.	29.0	104 36 19.7	14 34 51.2	18	17	8 25 46.8	9.9996464	- .21	26.48
	Apr. 18.0	138 43 22.9	-12 19 36.3	4	4	28 3 28.8	0.0020926	+ .23	26.12

SECONDARY NUCLEUS.

	Date.	Greenwich M. T.	α	δ	No. of Observations.		$\alpha' - \alpha$	$\delta' - \delta$
					α	δ		
1	1846, Jan.	24.0	7° 5' 5".7	- 1° 13' 2".4	15	15	- 77".6	+ 125".9
2	Feb.	5.0	18 11 32.3	2 36 0.7	24	24	98.2	200.9
3		17.0	31 35 1.6	4 55 59.7	25	25	144.4	306.9
4		25.0	42 19 15.8	7 5 23.3	12	11	208.0	388.4
5	Mar.	5.0	55 4 38.7	9 35 23.9	15	10	314.5	473.2
6		21.0	87 8 27.6	-13 51 10.0	12	12	-626.7	+530.7

FOLLOWING NUCLEUS.

Date.	Greenwich M. T.	α	δ	No. of Obs.		$\odot$	Log R	B	ε
				α	δ				
1852, Aug.	28.0	115° 34' 50".5	+20° 50' 47".9	5	5	155° 16' 39".3	0.0040798	- ".32	23° 27' 29".85
Sept.	21.0	146 2 34.7	+ 8 41 16.9	8	6	178 37 52.2	0.0013613	+ .06	30.21

PRECEDING NUCLEUS.

Date.	Greenwich M. T.	α	δ	No. of Obs.		$\odot$	Log R	B	ε
				α	δ				
1852, Sept.	21.0	145° 35' 18".1	+ 8° 58' 25".0	10	7	178° 37' 52".2	0 0013613	+ ".06	23° 27' 30".21

NOTE ON INTERIOR PLANETS.

By HENRY M. PARKHURST.

UPON comparing the series $\frac{1}{2}, \frac{1}{3}, \frac{2}{5}, \frac{3}{8}$, &c. with the periods of the planets, we find that each planet has a period a little longer than the assumed ratio to the next exterior, excepting in the cases of the *Earth* and *Venus*, where the complementary fraction is the ratio, and the period is a little less. The ratio of the planet next interior to *Mercury*, will be $\frac{3}{4} +$, and its period, about 35 days; and the next ratio will be $\frac{5}{4} +$, or its complement $\frac{8}{4} -$; the latter giving a period of 21 days, which is but one day longer than the period assigned by LEVERRIER to LESCARBAULT's new planet, upon the assumption of a circular orbit. Or, if we adopt the complementary ratio $\frac{5}{2} -$, with a period of about 53 days, the next ratio, $\frac{5}{14} +$, gives us again the period of 21 days. It seems, therefore, extremely probable that there is a planet between *Mercury* and LESCARBAULT's new planet, with an approximate period either of 35 or of 53 days.

The relation between the successive numbers 0, 1, 2, 3, 5, 8, 13, &c., that the square of each is alternately one less and one more than the product of the two adjoining numbers, which is the cause of the ambiguity in the period of the planet next to *Mercury*. I presume to be well known.

OBSERVATIONS OF LEUCOTHEA, THE COMET 1860 III., AND OF THE ECLIPSE OF THE SUN 1860 JULY 17.

MADE WITH THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — The places of the Asteroid and Comet corrected for refraction.]

LEUCOTHEA.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽³⁵⁾ — *	$\Delta\delta$	α ⁽³⁵⁾ 's apparent	δ
1860, May 19	^h 9 ^m 25 ^s 11.6	5	Rümker, 3276	^m — 0 ^s 24.18	+ 14' 20.19	^h 10 ^m 31 ^s 13.94	+ 8° 19' 17.79

Mean Place, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
Rümker, 3276	9	^h 10 ^m 31 ^s 35.92	+ 8° 5' 8.81	

COMET 1860 III.

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽³⁵⁾ — *	$\Delta\delta$	α ⁽³⁵⁾ 's apparent	δ
1860, July 11	^h 8 ^m 18 ^s 32.3	8	Weisse, X. 478	^m — 1 ^s 9.90	+ 6' 24.85	^h 10 ^m 26 ^s 24.47	+ 8° 53' 25.53
13	^h 8 ^m 40 ^s 18.9	3	B. A. C. 3726	+ 3' 48.21	+ 20' 13.21	10 48 51.00	+ 2' 6' 1.72
14	^h 8 ^m 26 ^s 23.3	8	Weisse, X. 1099	— 1' 57.04	+ 4' 22.89	10 59 12.73	— 1' 4' 31.77
16	^h 8 ^m 29 ^s 29.9	4	" XI. 304	+ 0' 18.27	— 0' 22.16	11 18 45.71	— 7' 4' 54.14

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
Weisse, X. 478	8	^h 10 ^m 27 ^s 32.63	+ 8° 47' 9.20	Weisse's Catalogue.
B. A. C. 3726	6	10 45 1.04	+ 1' 45' 59.77	British Association Catalogue.
Weisse, X. 1099	7	11 1 8.00	— 1' 8' 45.43	} Weisse's Catalogue.
" XI. 304	8	11 18 25.64	— 7' 5' 1.75	

ECLIPSE OF THE SUN 1860 JULY 17.

First contact,	18° 56' 20.57	Washington Mean Time.
Last contact,	20 50 53.64	" "

At 20^h 48^m 32^s.12 a chord between the points of the cusp was measured, whose length was 7' 12".67, the angle of position (counting from the north through the west) being 23°.25.

Washington, 1860, July 31.

LETTER FROM PROFESSOR KIRKWOOD TO THE EDITOR.

Bloomington, Indiana, 1860, July 28.

IN two of my equations in N^o. 136 of this Journal, the coefficients of the mean motions of the planets were, through some inadvertence, misplaced. These equations, as corrected, are included in the following table:—

(1.)	$n^{\text{IV}} - 2n^{(11)}$	$= 14217''$;	period of corresponding inequality,	91 years.
(2.)	$2n^{(7)} - n^{\text{IV}}$	$= 12152''.74$;	" " "	106 "
(3.)	$n^{\text{IV}} - 2n^{(19)}$	$= 9545''$;	" " "	135 "
(4.)	$n^{\text{IV}} - 2n^{(21)}$	$= 7107''$;	" " "	182 "
(5.)	$3n^{(10)} - n^{\text{IV}}$	$= 5809''$;	" " "	223 "
(6.)	$2n^{(20)} - n^{\text{IV}}$	$= 4011''$;	" " "	323 "
(7.)	$n^{\text{IV}} - 2n^{(6)}$	$= 2857''$;	" " "	454 "
(8.)	$11n^{(5)} - 5n^{\text{IV}}$	$= 1768''$;	" " "	733 "
(9.)	$10n^{\text{V}} - 3n^{(12)}$	$= 1406''$;	" " "	922 "
(10.)	$n^{(22)} - 3n^{\text{V}}$	$= 955''$;	" " "	1357 "

If we denote the mean daily motions of the third and fourth satellites of *Jupiter* by m^{III} and m^{IV} respectively, we have,

(a) $7m^{\text{IV}} - 3m^{\text{III}} = 160''.721$; the period of the corresponding inequality is 8064 days, or more than 1100 times the period of the third satellite.

In the *Saturnian* system (if we use the periods given in Loomis's Practical Astronomy), we obtain,

(b) $5m^{\text{VIII}} - m^{\text{VI}} = 403''.83$; period of inequality, 3209 days.

(c) $4m^{\text{VII}} - 3m^{\text{VI}} = 911''$; period of inequality, 1422 days.

The relations between the mean motions of *Mars* and the asteroids, expressed by the equations (1.) (8.), will doubtless enable astronomers to determine the mass of *Mars*, as has been suggested by Mr. NEWCOMB in the case of the inequality between *Mars* and *Juno*. Perhaps, however, the masses of *Venus* and *Mars* may be ascertained by their action upon the comet 1819 III, and that of DE VICO; the perihelions of the latter being very near the orbits of the former.

DANIEL KIRKWOOD.

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THE
ASTRONOMICAL JOURNAL.
No. 139.

VOL. VI.

CAMBRIDGE, 1860, SEPTEMBER 10.

NO. 19.

ON THE RESOLUTION OF SYMMETRICAL EQUATIONS WITH INDETERMINATE COEFFICIENTS.

By JOHN N. STOCKWELL.

1. THE theory of the secular variations of the planetary orbits gives rise to a system of symmetrical linear equations of the following form :—

$$\left. \begin{aligned} [0.0] N + [0.1] N' + [0.2] N'' + [0.3] N''' + \dots [0.n] N^{(n)} &= 0 \\ [1.0] N + [1.1] N' + [1.2] N'' + [1.3] N''' + \dots [1.n] N^{(n)} &= 0 \\ [2.0] N + [2.1] N' + [2.2] N'' + [2.3] N''' + \dots [2.n] N^{(n)} &= 0 \\ \vdots &\vdots \\ [n.0] N + [n.1] N' + [n.2] N'' + [n.3] N''' + \dots [n.n] N^{(n)} &= 0 \end{aligned} \right\} \quad (1)$$

in which the coefficients of $N, N', N'', \&c.$ are all known quantities, except the diagonal row, and $N, N', N'', \&c.$ being indeterminate. The coefficients of the diagonal row are of the following form :—

$$[0.0] = g - b, \quad [1.1] = g - b', \quad [2.2] = g - b'', \quad \dots [n.n] = g - b^{(n)}$$

$b, b', b'', \&c.$ being known quantities.

2. If we have n of these equations, and eliminate $N, N', N'', \&c.$, we shall obtain an equation in g of the degree n . But when we have more than four of these equations, the elimination of the unknown quantities $N, N', N'', \&c.$ becomes impracticable by the ordinary methods, on account of the great labor involved in the process. They also introduce into the resulting equations foreign factors depending on g ; and the introduction of these factors raises the degree of the resulting equations in g above the number of original equations. The method of *Determinants*, on the other hand, enables us to form these equations by a short and easy process. We shall therefore proceed to establish all the theorems which are

necessary for the formation of determinants of any order; and shall also give a general formula for the number of terms of which a determinant is composed, and also the number of terms of the different orders. These theorems were obtained by a process totally different from the ordinary methods of determinants,—a process which we believe both new and useful. After having given these theorems, we shall apply them more particularly to the resolution of the secular equations of the planetary orbits, which is the principal object of the present paper.

3. If we now suppose we have only two of equations (1), we may then write,

$$[0.0] N + [0.1] N' = 0, \quad [1.0] N + [1.1] N' = 0 \quad (2)$$

Eliminate N' , and we get,

$$\{[0.0] [1.1] - [1.0] [0.1]\} N = \{g - b\} (g - b') - [1.0] [0.1]\} N = 0. \quad (3)$$

Therefore,

$$[0.0] [1.1] - [1.0] [0.1] = 0. \quad (4)$$

This expression is the common denominator of the values of N , or N' , in equation (2). And hence a determinant may be defined as the common denominator of the values of the unknown quantities in a system of symmetrical equations. Equation (4) is evidently of the second order in g .

If we now eliminate N , N , N from three equations, we shall obtain the following determinant of the third order:—

$$\left. \begin{aligned} & [0.0] [1.1] [2.2] - [2.1] [1.2] [0.0] - [2.0] [0.2] [1.1] - [1.0] [0.1] [2.2] + [2.1] [1.0] [0.2] \\ & + [2.0] [0.1] [1.2] = 0. \end{aligned} \right\} \quad (5)$$

Lastly, from four equations we should obtain the following equation, which is a determinant of the fourth order in g :—

$$\begin{aligned} & [0.0] [1.1] [2.2] [3.3] - [3.2] [2.3] [0.0] [1.1] - [3.1] [1.3] [0.0] [2.2] - [3.0] [0.3] [1.1] [2.2] \\ & - [2.1] [1.2] [0.0] [3.3] - [2.0] [0.2] [1.1] [3.3] - [1.0] [0.1] [2.2] [3.3] + [1.3] [3.2] [2.1] [0.0] \\ & + [3.1] [1.2] [2.3] [0.0] + [2.3] [3.0] [0.2] [1.1] + [3.2] [2.0] [0.3] [1.1] + [3.1] [1.0] [0.3] [2.2] \\ & + [1.3] [3.0] [0.1] [2.2] + [1.2] [2.0] [0.1] [3.3] + [2.1] [1.0] [0.2] [3.3] + [1.0] [0.1] [3.2] [2.3] \\ & + [2.0] [0.2] [3.1] [1.3] + [3.0] [0.3] [2.1] [1.2] - [1.3] [3.0] [0.2] [2.1] - [3.1] [1.2] [2.0] [0.3] \\ & - [1.0] [0.2] [2.3] [3.1] - [0.1] [1.3] [3.2] [2.0] - [1.2] [2.3] [3.0] [0.1] - [2.1] [1.0] [0.3] [3.2] \end{aligned} = 0 \quad (6)$$

The whole theory of the formation of determinants may be derived from a careful analysis of equations (4), (5), and (6).

4. We shall denote the order of any term of a determinant by the number of factors it contains from the diagonal row. Then, calling the terms which are independent of this row the *absolute term*, we may enunciate the following theorems.

THEOREM I. *Each term of a determinant contains one factor from each of the original equations, and only one.*

As a simple corollary, we may add, — *If one of the original equations be multiplied by any number, the determinant is also multiplied by the same number.*

THEOREM II. *The different orders of terms in a determinant are n , $n-2$, $n-3$, ..., $n-(n-1)$, and $n-n$, there being no terms of the order $n-1$; and $n-n$ evidently denoting the absolute term.*

THEOREM III. *The coefficient of the n^{th} term of the diagonal row is the determinant of the order $n-1$; and the coefficients of the other terms of the diagonal are derived from the coefficient of the n^{th} term of the single interchange of n and $n-1$, n and $n-2$, ..., n and $n-(n-1)$.*

This last theorem enables us easily to form all that part of a determinant which depends on the diagonal row, or all except the absolute term.

5. The formation of the absolute term requires two distinct processes. We must first multiply the absolute term of a determinant of the order $n-1$, by $[n.0]$, $[n.1]$, $[n.2]$, ..., $[n.(n-1)]$, and simply change 0, 1, 2, 3, &c. to $n-1$, in those terms, into n , and also change the sign of the terms, and we shall obtain one part of the absolute term. The other part of these terms are derived from those of the second order in the determinant of the order n , by the single interchange of n and $n-1$, n and $n-2$, n and $n-3$, ..., n and $n-n$, and changing the sign of the terms. This will perhaps appear more plainly by comparing equations (5) and (6). In this case $n=3$. We must therefore multiply $[1.2] [2.0] [0.1] + [1.0] [0.2] [2.1]$ by $[3.0]$, $[3.1]$, and $[3.2]$, and we get the six negative terms of equation (6). The other three terms are derived from the terms $- [2.1] [1.2] [0.0] [3.3] - [2.0] [0.2] [1.1] [3.3] - [1.0] [0.1] [2.2] [3.3]$, of equation (6), by the single interchange of 0 and 3, 1 and 3, 2 and 3, and changing the sign.

6. A further comparison of equations (4), (5), and (6) enables us to deduce the following formula for the sum of all the terms of which a determinant is composed, and also the number of terms of each order.

$$\begin{aligned} S = & 1 \cdot \frac{1.2.3.4 \dots n}{1.2.3.4 \dots n} + 1 \cdot \frac{3.4.5.6 \dots n}{1.2.3.4 \dots (n-2)} + (1.3-1) \frac{4.5.6.7 \dots n}{1.2.3.4 \dots (n-3)} \\ & + (1.3-1) \cdot 4 + 1 \cdot \frac{5.6.7.8 \dots n}{1.2.3.4 \dots (n-4)} + (1.3-1) \cdot 4 + 1.5-1 \cdot \frac{6.7.8 \dots n}{1.2.3.4 \dots (n-5)} \\ & + (1.3-1) \cdot 4 + 1.5-1.6+1 \cdot \frac{7.8.9 \dots n}{1.2.3.4 \dots (n-6)} \\ & + \{ (1.3-1) \cdot 4 + 1.5-1.6+1.7-1 \} \cdot \frac{8.9.10 \dots n}{1.2.3.4 \dots (n-7)} + \&c. \\ & + [\{ (1.3-1) \cdot 4 + 1.5-1.6+1.7-1.8+1 \} \dots (n-1) \mp 1] \cdot n \pm 1 \\ & = 1.2.3.4.5.6 \dots n. \end{aligned} \quad (7)$$

The upper sign when n is an even number, and the lower when n is odd.

7. The fractional terms of formula (7) denote the number of combinations of the terms of the diagonal row, taken in sets

which are represented by the last factor of each denominator; and the coefficient of the n^{th} term of the series denotes the number of terms which are independent of the diagonal row in a determinant of the order n . Again, by adding the terms

of the second member of formula (7), it becomes equal to the third member. Hence it follows that the whole number of terms of which a determinant of the n^{th} order is composed is equal to the continued product of the natural numbers from 1 to n inclusive. We may also observe that the number of positive terms is equal to the number of negative terms in a determinant of any order.

8. Having given the necessary theorems and rules for the resolution of any number of symmetrical equations, we shall now proceed to apply them to the secular equations of the planetary orbits.

For this purpose we shall suppose $e, e', e'', \&c.$, $\omega, \omega', \omega'', \&c.$, to denote the eccentricities and longitudes of the perihelions respectively of the planets *Mercury*, *Venus*, the *Earth*, *Mars*, $\&c.$, at a given epoch, and shall put

$$\begin{aligned} h &= e \cdot \sin \omega, & l &= e \cdot \cos \omega, \\ h' &= e' \cdot \sin \omega', & l' &= e' \cdot \cos \omega', \\ &\&c. & &\&c. \end{aligned}$$

It is shown by LA PLACE (*Mécanique Céleste*, Book II. § 55) that the differential equations of $h, h', h'', l, l', l'', \&c.$ are as follows:—

$$\left. \begin{aligned} \frac{dh}{dt} &= \{ (0.1) + (0.2) + (0.3) + \&c. \} \cdot l - [0.1] \cdot l' - [0.2] \cdot l'' - [0.3] \cdot l''' - \&c. \\ \frac{dl}{dt} &= -\{ (0.1) + (0.2) + (0.3) + \&c. \} \cdot h + [0.1] \cdot h' + [0.2] \cdot h'' + [0.3] \cdot h''' + \&c. \\ \frac{dh'}{dt} &= \{ (1.0) + (1.2) + (1.3) + \&c. \} \cdot l' - [1.0] \cdot l - [1.2] \cdot l'' - [1.3] \cdot l''' - \&c. \\ \frac{dl'}{dt} &= -\{ (1.0) + (1.2) + (1.3) + \&c. \} \cdot h' + [1.0] \cdot h + [1.2] \cdot h'' + [1.3] \cdot h''' + \&c. \\ \frac{dh''}{dt} &= \{ (2.0) + (2.1) + (2.3) + \&c. \} \cdot l'' - [2.0] \cdot l - [2.1] \cdot l' - [2.3] \cdot l''' - \&c. \\ \frac{dl''}{dt} &= -\{ (2.0) + (2.1) + (2.3) + \&c. \} \cdot h'' + [2.0] \cdot h + [2.1] \cdot h' + [2.3] \cdot h''' + \&c. \\ &\&c. & &\&c. \end{aligned} \right\} \quad (8)$$

the coefficients (0.1), (0.2), $\&c.$, [0.1], [0.2], $\&c.$, (1.0), (1.2), $\&c.$, [1.0], [1.2], $\&c.$, being quantities depending on the masses and mean motions of the disturbing planets.

9. The integrals of equations (8) are found by putting

$$\left. \begin{aligned} h &= N \cdot \sin (gt + \beta), & l &= N \cdot \cos (gt + \beta) \\ h' &= N' \cdot \sin (gt + \beta), & l' &= N' \cdot \cos (gt + \beta) \\ &\&c. & &\&c. \end{aligned} \right\} \quad (9)$$

If we substitute these values in equations (8) they will become, after transposing,

$$\left. \begin{aligned} \{ g - (0.1) - (0.2) - (0.3), - \&c. \} N + [0.1] N' + [0.2] N'' + [0.3] N''' + \&c. &= 0 \\ \{ g - (1.0) - (1.2) - (1.3), - \&c. \} N' + [1.0] N + [1.2] N'' + [1.3] N''' + \&c. &= 0 \\ \{ g - (2.0) - (2.1) - (2.3), - \&c. \} N'' + [2.0] N + [2.1] N' + [2.3] N''' + \&c. &= 0 \\ &\&c. & &\&c. \end{aligned} \right\} \quad (10)$$

the number of these equations being equal to the number of planets whose mutual action is considered. These equations are entirely similar to equations (1).

10. Before proceeding further, it is important to introduce into our researches some simplifications which arise from the

structure of the system of the world. These simplifications arise from the relations which subsist between the coefficients [0.1], [1.0]; [0.2], [2.0]; [1.2], [2.1]; [1.3], [3.1], $\&c.$: and depend upon the equations,

$$[0.1] m \sqrt{a} = [1.0] m' \sqrt{a'}, \quad [0.2] m \sqrt{a} = [2.0] m'' \sqrt{a''}, \quad [1.2] m' \sqrt{a'} = [2.1] m'' \sqrt{a''} \quad \&c. \quad (11)$$

$m, a, m', a', m'', a'', \&c.$, being the masses and mean distances of the different bodies of the system.

From these equations we easily obtain,

$$\left. \begin{aligned} [1.2] [2.0] [0.1] &= [2.1] [1.0] [0.2] & [1.0] [0.2] [2.3] [3.1] &= [1.3] [3.2] [2.0] [0.1] \\ [1.3] [3.2] [2.1] &= [3.1] [1.2] [2.3] & [1.2] [2.3] [3.0] [0.1] &= [1.0] [0.3] [3.2] [2.1] \\ [3.0] [0.2] [2.3] &= [3.2] [2.0] [0.3] & &\&c. & &\&c. \end{aligned} \right\} \quad (12)$$

Substituting these conditions in equations (5) and (6), they will become,

$$[0.0] [1.1] [2.2] - [2.1] [1.2] [0.0] - [2.0] [0.2] [1.1] - [1.0] [0.1] [2.2] + 2 \cdot [1.2] [2.0] [0.1] = 0. \quad (13)$$

$$\left. \begin{aligned} & [0.0] [1.1] [2.2] [3.3] - [3.2] [2.3] [0.0] [1.1] - [3.1] [1.3] [0.0] [2.2] - [3.0] [0.3] [1.1] [2.2] \\ & - [2.1] [1.2] [0.0] [3.3] - [2.0] [0.2] [1.1] [3.3] - [1.0] [0.1] [2.2] [3.3] + 2 \cdot [1.3] [3.2] [2.1] [0.0] \\ & + 2 \cdot [2.3] [3.0] [0.2] [1.1] + 2 \cdot [3.1] [1.0] [0.3] [2.2] + 2 \cdot [2.0] [0.1] [1.2] [3.3] + [1.0] [0.1] [3.2] [2.3] \\ & + [2.0] [0.2] [3.1] [1.3] + [3.0] [0.3] [2.1] [1.2] - 2 \cdot [1.3] [3.0] [0.2] [2.1] - 2 \cdot [1.0] [0.2] [2.3] [3.1] \\ & - 2 \cdot [1.2] [2.3] [3.0] [0.1] \end{aligned} \right\} = 0. \quad (14)$$

11. We are now prepared to form the determinant of the fifth order; and for astronomical uses we must derive it from equation (14); but when the coefficients of equations (1) are such that equations (12) are not satisfied, we must derive it from equation (6). Therefore, according to Theorem III. and Art. 5th, we may write the determinant of the fifth order as follows:—

$$\left. \begin{aligned} & [0.0] [1.1] [2.2] [3.3] [4.4] - [4.3] [3.4] [0.0] [1.1] [2.2] - [4.2] [2.4] [0.0] [1.1] [3.3] \\ & - [4.1] [1.4] [0.0] [2.2] [3.3] - [4.0] [0.4] [1.1] [2.2] [3.3] - [3.2] [2.3] [0.0] [1.1] [4.1] \\ & - [3.1] [1.3] [0.0] [2.2] [4.4] - [3.0] [0.3] [1.1] [2.2] [4.4] - [2.1] [1.2] [0.0] [3.3] [4.4] \\ & - [2.0] [0.2] [1.1] [3.3] [4.4] - [1.0] [0.1] [2.2] [3.3] [4.4] \\ & + 2 \cdot [4.3] [3.2] [2.4] [0.0] [1.1] + 2 \cdot [4.3] [3.1] [1.4] [0.0] [2.2] + 2 \cdot [4.2] [2.1] [1.4] [0.0] [3.3] \\ & + 2 \cdot [3.2] [2.1] [1.3] [0.0] [4.4] + 2 \cdot [4.3] [3.0] [0.4] [1.1] [2.2] + 2 \cdot [4.2] [2.0] [0.4] [1.1] [3.3] \\ & + 2 \cdot [3.2] [2.0] [0.3] [1.1] [4.4] + 2 \cdot [4.0] [0.1] [1.4] [2.2] [3.3] + 2 \cdot [3.0] [0.1] [1.3] [2.2] [4.4] \\ & + 2 \cdot [1.2] [2.0] [0.1] [3.3] [4.4] \\ & + [4.1] [1.4] [3.2] [2.3] [0.0] + [4.2] [2.4] [3.1] [1.3] [0.0] + [4.3] [3.4] [2.1] [1.2] [0.0] \\ & - 2 \cdot [4.2] [2.1] [1.3] [3.4] [0.0] - 2 \cdot [4.2] [2.3] [3.1] [1.4] [0.0] - 2 \cdot [4.1] [1.2] [2.3] [3.4] [0.0] \\ & + [4.0] [0.4] [3.2] [2.3] [1.1] + [4.2] [2.4] [3.0] [0.3] [1.1] + [4.3] [3.4] [2.0] [0.2] [1.1] \\ & - 2 \cdot [4.2] [2.0] [0.3] [3.4] [1.1] - 2 \cdot [4.2] [2.3] [3.0] [0.4] [1.1] - 2 \cdot [4.0] [0.2] [2.3] [3.4] [1.1] \\ & + [4.0] [0.4] [3.1] [1.3] [2.2] + [4.1] [1.4] [3.0] [0.3] [2.2] + [4.3] [3.4] [1.0] [0.1] [2.2] \\ & - 2 \cdot [4.1] [1.3] [3.0] [0.1] [2.2] - 2 \cdot [4.0] [0.1] [1.3] [3.4] [2.2] - 2 \cdot [4.1] [1.0] [0.3] [3.4] [2.2] \\ & + [4.0] [0.4] [2.1] [1.2] [3.3] + [4.1] [1.4] [2.0] [0.2] [3.3] + [4.2] [2.4] [1.0] [0.1] [3.3] \\ & - 2 \cdot [4.1] [1.2] [2.0] [0.4] [3.3] - 2 \cdot [4.0] [0.1] [1.2] [2.4] [3.3] - 2 \cdot [4.1] [1.0] [0.2] [2.4] [3.3] \\ & + [3.0] [0.3] [2.1] [1.2] [4.4] + [3.1] [1.3] [2.0] [0.2] [4.4] + [3.2] [2.3] [1.0] [0.1] [4.4] \\ & - 2 \cdot [3.1] [1.2] [2.0] [0.3] [4.4] - 2 \cdot [3.0] [0.1] [1.2] [2.3] [4.4] - 2 \cdot [3.1] [1.0] [0.2] [2.3] [4.4] \\ & - 2 \cdot [4.0] [0.4] [3.1] [1.2] [2.3] - 2 \cdot [4.1] [1.4] [3.0] [0.2] [2.3] - 2 \cdot [4.2] [2.4] [3.0] [0.1] [1.3] \\ & - 2 \cdot [4.3] [3.4] [2.0] [0.1] [1.2] - 2 \cdot [3.0] [0.3] [4.1] [1.2] [2.4] - 2 \cdot [3.1] [1.3] [4.0] [0.2] [2.4] \\ & - 2 \cdot [3.2] [2.3] [4.0] [0.1] [1.4] - 2 \cdot [2.0] [0.2] [4.3] [3.1] [1.4] - 2 \cdot [2.1] [1.2] [4.3] [3.0] [0.4] \\ & - 2 \cdot [1.0] [0.1] [4.3] [3.2] [2.4] \\ & + 2 \cdot [4.2] [2.3] [3.0] [0.1] [1.4] + 2 \cdot [4.2] [2.3] [3.1] [1.0] [0.4] + 2 \cdot [4.3] [3.1] [1.2] [2.0] [0.4] \\ & + 2 \cdot [4.3] [3.2] [2.1] [1.0] [0.4] + 2 \cdot [4.0] [0.2] [2.3] [3.1] [1.4] + 2 \cdot [4.0] [0.3] [3.2] [2.1] [1.4] \\ & + 2 \cdot [4.1] [1.0] [0.2] [2.3] [3.4] + 2 \cdot [4.0] [0.3] [3.1] [1.2] [2.4] + 2 \cdot [4.1] [1.3] [3.0] [0.2] [2.4] \\ & + 2 \cdot [4.2] [2.0] [0.1] [1.3] [3.4] + 2 \cdot [4.3] [3.0] [0.2] [2.1] [1.4] + 2 \cdot [4.2] [2.1] [1.0] [0.3] [3.4] \end{aligned} \right\} = 0. \quad (15)$$

12. As an example of this formula, we shall apply it to the resolution of the following equations, in which the coefficients are chosen so as to satisfy equations (12).

$$\left. \begin{aligned} (g-12) N + N' + 2 N'' + 3 N''' + 4 N^{IV} &= 0, \\ N + (g-14) N' + 3 N'' + 4 N''' + 5 N^{IV} &= 0, \\ 2 N + 3 N' + (g-17) N'' + 5 N''' + 6 N^{IV} &= 0, \\ 3 N + 4 N' + 5 N'' + (g-20) N''' + 7 N^{IV} &= 0, \\ 4 N + 5 N' + 6 N'' + 7 N''' + (g-23) N^{IV} &= 0. \end{aligned} \right\} \quad (16)$$

Making the necessary substitutions in equation (15) we shall obtain,

$$g^5 - 86 \cdot g^4 + 2729 \cdot g^3 - 38336 \cdot g^2 + 213674 \cdot g - 204082 = 0. \quad (17)$$

And the roots of this equation will satisfy equations (16), by attributing suitable values to N , N' , &c.

13. The formation of determinants of the higher orders presents no difficulties whatever, except the great labor of transcribing them. But this difficulty is sufficient to deter the most ambitious from forming determinants higher than the sixth or seventh order, because then the number of terms increases with frightful rapidity. Therefore, instead of en-

larging further upon this method of solution, we will now explain a method by which we can resolve *numerical* equations which will produce determinants of the eighth or even of the tenth order, with comparative facility.

14. For this purpose, suppose we have ten of equations (1), with numerical coefficients. If we then eliminate N^V , N^{VI} , N^{VII} , N^{VIII} , and N^{IX} , we shall obtain five equations of the following form:—

$$\left. \begin{aligned} (Ag^2 + Bg + C) N + (A'g^2 + B'g + C') N' + (A''g^2 + B''g + C'') N'' \\ + (A'''g^2 + B'''g + C''') N''' + (A^{IV}g^2 + B^{IV}g + C^{IV}) N^{IV} \end{aligned} \right\} = 0. \quad (18)$$

Now, making the coefficients of N , N' , N'' , N''' , and N^{IV} equal to those in equations (1), and substituting in the determinant of the fifth order, we shall obtain an equation of the tenth degree in g . The roots of this equation being then substituted in equations (18), we can then continue the elim-

ination, and find the values of N , N' , N'' , &c., in terms of N .

15. As an example of this method we shall apply it to equations (16). If we eliminate N''' and N^{IV} from these equations, we shall obtain the three which follow.

$$\left. \begin{aligned} (g-12) N - (2g-32) N' + (g-21) N'' &= 0, \\ (4g^2-162 \cdot g + 1538) N - (5 \cdot g^2 - 192 \cdot g + 1640) N' + (2g-52) N'' &= 0, \\ (g-31) N' - (1g^2-178 \cdot g + 1617) N + (3g^2-143 \cdot g + 1490) N' &= 0. \end{aligned} \right\} \quad (19)$$

Therefore,

$$\begin{aligned} [0.0] &= g - 12, & [0.1] &= -2g + 32, & [0.2] &= g - 21; \\ [1.1] &= 4g^2 - 162 \cdot g + 1538, & [1.0] &= -5g^2 + 192 \cdot g - 1640, & [1.2] &= 2g - 52; \\ [2.2] &= g - 31, & [2.0] &= -4g^2 + 178 \cdot g - 1617, & [2.1] &= 3g^2 - 143 \cdot g + 1490. \end{aligned}$$

Substituting these values in equation (5), we shall get equation (17).

Brecksville, Ohio, 1860, July 10.

SOLAR ECLIPSE OF 1860, JULY 18.

F. AT WEST POINT, N. Y.

[From a Letter of Lieutenant SCHOFIELD to the Editor.]

THE atmosphere was clear and calm, and the observations were made under favorable circumstances. The discrepancies were doubtless due to difference in power of the instruments used.

The last contact agrees very nearly with that computed from the elements in the *American Ephemeris*.⁽¹⁾ The first contact was observed some twenty-odd seconds later than the computed time.

Observer.	Instrument.	West Point Mean Time.	
		First Contact.	Last Contact.
		h m s	h m s
Prof. BARTLETT,	Large refractor,	19 10 36.5	21 12 47.7
Lieut. SCHOFIELD,	Small refractor,	41.3	41.8
Lieut. MENDELL,	“ “	40.3	40.5

West Point, 1860, August 21.

J. M. SCHOFIELD.

⁽¹⁾ This ephemeris is based on PEIRCE's Tables. The Cloverden observations (p. 136) made the first contact later by 8^s.5, and the last contact later by 7^s.5, than the computations of the *Am. Ephem.*—G.

G. AT SPRINGHILL, ALA.

[Translation of a Letter from Rev. Mr. CORNETTE to Prof. SILLIMAN.]

The solar eclipse of yesterday having much occupied the attention of observers, I have felt it a duty to send you the three values which I obtained, with my pupils at Springhill, latitude $30^{\circ} 41'$, longitude $88^{\circ} S$, west from Greenwich.

A chronometer corrected on the evening of the 17th, and by equal altitudes of the sun on the 18th, immediately after the eclipse, enabled us to obtain the true times of the phenomenon as follows:—

Beginning of eclipse,	^h 18 ^m 10 ^s	true time.
Maximum “ (7' 33" N.)	18 50	
End “	19 30 2.46	

Springhill, 1860, July 19.

H. AT COAST-SURVEY OFFICE, WASHINGTON.

[From a Report of CHAS. A. SCHOTT, Esq. to Prof. BACHE, Superintendent.]

The observations were made at a station in the vicinity of the Coast-Survey Office, in latitude $38^{\circ} 53' 3''.8$, longitude $77^{\circ} 0' 7''.8 W.$ from Greenwich, these values being derived by direct measurement from the trigonometrical station in one of the office buildings.

The telescope was the one ordinarily used by me for observing solar spots, (FRAUNHOFER and UTSCHNEIDER, C. S. No. 12,) of 4 feet focal length, and equatorially mounted. A power of 55 was used, and the sun's image projected against a screen in a dark box. The last contact, and the contacts with the solar spots, were observed with a power of about 175. The local time was determined with a Gambey sextant, from observations of equal altitudes of the sun, using a mean time chronometer (KESSELS, No. 1287).

Both before and after the eclipse two sets of observations of the solar spots were taken, according to the mode of observation employed by Mr. CARRINGTON.

About $4\frac{1}{2}$ A. M. the sky was clear; but gradually a haze rose over the river, and interfered in some degree with the observations of the first contact. These were,—

Chronom. Time.			Observer.	
^h	^m	^s		
11 26	9.2	— 1.5	CHAS. A. SCHOTT ⁽¹⁾	} same telescope.
	9.5		A. S. WADSWORTH,	
	6.5		J. H. PATTON,	
	7.6		L. F. POURTALES. ⁽²⁾	
	...		W. L. NICHOLSON. ⁽³⁾	
Mean,	11 26	7.8		
	— 4 29	40.8	Chronometer correction.	
July 17 ¹	18 56	27.0	Mean time of first contact.	

(¹) The correction 1.5 is from a close estimate of the interval of the same limit of projection at last contact (allowing for difference in power of telescope), the moon producing a sensible indentation at 9.2. The exact point of contact was marked by a spider-line.

The beginning was not caught with sufficient exactness to deserve entire confidence. The horizon was obscured by cirrus clouds.

The end was at $19^h 35^m 57.36$ Mean Time.

The effect of the eclipse was not very marked. The diminution of light showed no other peculiarity than that of imparting a pale and sad tint to all surrounding objects.

The state of the atmosphere enabled me to determine the coördinates of the late comet from June 28 till July 9. Should these observations have interest for any astronomers who were unable to follow it during that period, my results shall be at their disposal.

A. CORNETTE, S. J.

[Drawings of the moon's limb, as projected at different moments, are given by Mr. SCHOTT to show the position of its irregularities relative to some of the smaller solar spots. The index-letters, *a, b, c, d*, employed below, refer to points of the moon's limb thus marked. These drawings are, to my great regret, unavoidably omitted here. — G.]

At $12^h 29^m 8^s$ the spot numbered 241, accompanied by a smaller one, seemed to slide down the slope *cd*, and gradually disappear. At *a* is a remarkable table-land; *b* and *c* were apparently the highest lunar elevations, but there were two other remarkable mountains, close together, with a deep valley between. It was only on this part of the limb that the lunar outline was irregular.

	Chronometer Time.		
	^h	^m	^s
The small spot north of 236 reappeared,	12	19	30
Spot 239, first contact,	21	2	
last “	21	53	
Spot 242 reappeared (WADSWORTH obs.)	49	15	
Spot 211 “	12	50	39
Spot 239 “ penumbra,	1	3	2
small nucleus,	3	29	
large and 2d nucleus,	4	3.5	
second limb,	4	16	
last contact penumbra,	1	4	50

Assistant WADSWORTH remarked a perceptible change of outline on spot 239 as it disappeared behind a lunar elevation. I saw neither change of color nor of outline in any spot. Upon the opposite (or western) cusp, there was a remarkable change in the moon's outline (see angle *a* in the sketch). This was noticed towards the close of the eclipse.

(²) Observed with a smaller telescope (C. S. No. 27), direct, with a red shade-glass, the pocket chronometer being compared with No. 1287 before and after the observation.

(³) Observation not satisfactory, the telescope being too small.

About this time the undulation of the moon's limb increased, and remained so until the eclipse was over.

Observations of last Contact.

Chronometer Time.	Observer.
^h ^m ^s 1 20 46.5	CHARLES A. SCHOTT.
47.3	A. S. WADSWORTH.
47.5	J. H. PATTON.
45.3	L. F. POURTALES (outline wavy).
44.5 + 1.0	W. L. NICHOLSON. ⁽¹⁾

Mean, 1 20 46.4

—4 29 41.6 Chronometer correction.

July 17^d 20 51 4.8 Mean time of last contact.

[Mr. SCHOTT gives with his report full series of meteorologi-

⁽¹⁾ Mr. NICHOLSON observed with a larger telescope than before, and is certain of having anticipated the last contact by 1^s.

Coast-Survey Office, Washington, 1860, July 26.

cal observations at intervals of ten minutes from 5^h 56^m till 9^h 36^m A. M., also a careful drawing of spot 236, as seen with a power of 175, as well as the detailed observations for determining the positions of the spots, and a chart of the sun's disc at the time of the eclipse. This latter I hope soon to be able to furnish to the readers of the Journal. — G.]

The following Table shows the heliographic positions of the spots.

Spot No.	Astronomical Date.	Latitude.	Longitude.
236	July 17.823	N. 19° 30'	254° 36'
237	.897	S. 5 57	245 45
238	.897	S. 9 5	239 0
239	.823	N. 16 50	178 45
240	.823	S. 18 35	184 30
241	.823	N. 9 25	188 14
242	17.749	N. 8 35	184 5

CHARLES A. SCHOTT.

I.

OBSERVATIONS MADE AT COAST-SURVEY STATION, GUNSTOCK MOUNTAIN,

By PROF. A. D. BACHE, SUPERINTENDENT U. S. COAST SURVEY.

1. Coast-Survey station *Gunstock* is in the township of Guilford, Belknap County, New Hampshire, latitude 43° 31' 3", longitude 71° 21' 50" (4^h 45^m 27.4 approx.) west of Greenwich; and has an elevation of about 2440 feet above the mean level of the sea.

The instruments having been carefully readjusted for the purpose, hourly observations of magnetic declination and horizontal force, in connection with regular meteorological observations, were made two days before the beginning, and (except the observations of the horizontal force²) continued for two days after the end of the eclipse.

On these four days during the two hours next preceding the time of beginning, and the two following that of the ending of the eclipse, the magnetic and meteorological observations were made half-hourly, and during the times corresponding with that of the eclipse they were made every two minutes, and during the eclipse itself observations of the temperature of the air and solar radiation were made every half-minute. So far as practicable, all these observations were made simultaneously with similar ones which were assigned for the party sent to Cape Chudleigh, Labrador, under the charge of Professor ALEXANDER.

During the mornings of July 16 and 17, at times corresponding with that of the eclipse on the 18th, observations of the transits of solar spots, and drawings of the same, were made in connection with experiments with screens of different colors, practice of the aids in counting and noting time, etc., etc.

⁽²⁾ In a violent storm on the morning of the 19th the bifilar tent was blown down, deranging the instruments to such an extent as to prevent farther observations of horizontal force.

The weather on the morning of the 18th proved remarkably favorable. From sunrise until 10 A. M. scarcely a cloud obscured the sky, the temperature of the air ranging from 59° to 65° Fahr., with a light breeze from the southwest at no time exceeding two miles an hour.

The instrument which I used was a DOLLOND telescope of 6 feet focal length and aperture of 4 inches (C. S. No. 1), equatorially mounted, and provided with a dark box for projecting the image of the sun upon a screen. After some experiments the magnifying power of 64 was selected for observing the times; but for making drawings of the spots the power 187 was used. With the power 64, the diameter of the sun's projected image was 5.7 inches. The transits were observed upon a white screen, and the contacts upon one of light straw-color, with parallels in red.

2. FIRST CONTACT. — The minutes, seconds, and half-seconds were counted aloud by Mr. TOOMER, who was stationed at the chronometer.

First contact of an elevation on moon's limb,	^h ^m ^s 7 22 46.4
" " true line of limb,	48.4
Disc fully on (two accordant observations),	7 22 51.9

The point of contact agreed precisely, as observed, with previous computation. The elevation referred to above was the western of two which were noticed shortly afterward. Contact had certainly not taken place at 45°, and probably not at 48°. The sun's limb was well defined, with but little tremulous motion.

Mr. McDONNELL, who observed the contacts with a Fraunhofer telescope of 46 inches focal length and an aperture of

3 inches, with a power 84, noted the time of disc fully on as 7^h 22^m 51^s.6.

Mr. DEAN observed the contacts with the telescope of the 30-inch theodolite (No. 1, C. S.), having a focal length of 46 inches and aperture of 3 inches, and using a power of about 175, with the darkest shade of London smoke. This instrument being at some distance from the others, he noted the time from a sidereal chronometer (HUTTON, No. 202). The observed time of disc fully on was 7^h 22^m 53^s.7, Gunstock mean time; but Mr. DEAN remarks that this is perhaps two seconds too late.

When the moon's limb had fully passed, I noticed two prominences near the point of beginning, the westerly one

having made the first contact. This certainly had not occurred at 41', and probably not at 44'. The edge of the moon was well defined, and had but little apparent motion.

3. POSITION OF SPOTS.—The adopted nomenclature denotes groups of spots by capital letters, *A, B, C, D*, etc., and individual members of groups by the small letters, *a, b, c, d*, etc.. The field of the telescope was divided into octants by four spider-lines, and the eight radii distinguished by numerals 0 to 7, 0 denoting the North, 2 the East, 4 the South, and 6 the West lines respectively. The following four sets of transit observations were made, on the 17th and 18th July, to determine the position of the spots.

1. July 17.

No. 1.			No. 2.			No. 3.			No. 4.			No. 5.		
Object.	Thread.	Time, A.M.	Object.	Thread.	Time, A.M.	Object.	Thread.	Time, A.M.	Object.	Thread.	Time, A.M.	Object.	Thread.	Time, A.M.
☉ I	3	10 ^h 55 ^m 5.0	☉ I	3	11 ^h 4 ^m 36.0	☉ I	5	11 ^h 8 ^m 50.8	☉ I	3	11 ^h 12 ^m 39.0	☉ I	1	11 ^h 21 ^m 46.8
II	1	19.8	II	1	4 48.7	II	3	8 56.5	II	1	12 49.0	II	3	21 51.2
III	0	55 40.2	III	0	5 10.0	III	0	9 22.0	III	4	13 11.7	III	0	22 17.2
Ab I	1	56 13.2	Ab I	1	41.6	Ba I	3	10 0.0	Bb I	3	13 50.0	C I	3	23 28.8
II	0	23.2	II	0	5 52.8	II	4	10.8	II	4	14 12.2	II	4	23 53.0
III	7	10 56 33.0	III	7	6 3.7	III	5	10 21.8	C I	3	16.5	E I	1	24 6.2
			D I	3	6 28.7 ⁽¹⁾	E I	1	11 10.0 ⁽¹⁾	C I	3	31.0	II	0	18.1
			II	4	7 4.9	II	0	22.8	Bb III	5	36.5	C III	5	19.2
			☉ I	4	25.3	III	7	35.0	C II	4	14 48.0	E III	7	31.8 ²
			D III	5	42.3	☉ I	0	11 37.0	D II	4	15 6.0	☉ I	0	lost
			☉ II	7	7 45.3	II	7	12 5.3	C III	5	21.1	II	7	24 59.6
			III	0	11 8 4.4	III	5	11 12 6.8	☉ I	4	27.5	III	5	25 3.5
									D III	5	15 42.8	☉ I	3	32.3
									☉ II	7	lost	II	1	25 45.7
									☉ III	5	11 16 5.4	III	0	26 7.3
												C I	3	27 10.8
												II	4	27 41.0
												III	5	28 17.8
												☉ I	4	23 0
												II	7	28 41.0
												III	5	11 29 1.7

(¹) Middle of spot observed.

(²) Observation late.

(To be continued.)

CORRIGENDA.

N^o. 138, p. 139, table of normals, columns 8, 11, 12, for δ, a, δ , read δ', a', δ' .

" p. 140, col. 1, line 14, for that the perihelion, occurring in September, read that, the perihelion occurring in September.

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NO. 20.

SOLAR ECLIPSE OF 1860, JULY 18.

I.

OBSERVATIONS MADE AT COAST-SURVEY STATION, GUNSTOCK MOUNTAIN,

By PROF. A. D. BACHE, SUPERINTENDENT U. S. COAST SURVEY.

(Continued from page 152.)

II. July 18, before the Eclipse.

No. 1.			No. 2.			No. 3.			No. 4.		
Object.	Thread.	Time, A. M.	Object.	Thread.	Time, A. M.	Object.	Thread.	Time, A. M.	Object.	Thread.	Time, A. M.
☉ I	3	^h 6 ^m 58 ^s 45.5	☉ I	1	^h 7 ^m 2 ^s 52.0	☉ I	3	^h 7 ^m 8 ^s 51.3	☉ I	3	^h 7 ^m 13 ^s 15.8 ⁴
II	1	58 55.2	II	3	2 59.8	II	1	9 18.8	II	1	13 48.8
III	0	59 18.3	III	0	3 23.8	III	4	33.2	III	4	14 0.4
Ab I	1	35.8	Ab I	1	32.3	Ba? I	3	9 48.8	Bb I	3	16.8
II	0	6 59 50.7	II	0	3 55.9	II	4	10 12.8	II	4	14 47.8
III	7	7 0 6.8	III	7	4 20.0	III	5	10 37.0	III	5	15 19.8
☉ I	4	1 33.8?	E I	1	5 2.0 ¹	☉ I	4	11 48.8	☉ I	4	16 15.8
II	7	1 56.9	II	0	16.8	II	7	12 1.8	II	7	16 26.2
III	5	7 2 8.9	III	7	31.8 ²	III	5	7 12 32.0	III	5	7 17 2.0 ⁴
			☉ I	0	5 38.8						
			II	5	6 4.8						
			III	7	7 6 10.2						

(¹) Middle of spot observed.

(²) Middle of front spot.

(⁴) Perhaps 10^s late.

III. July 18, during the Eclipse.

No. 1.			No. 2.			No. 3.		
Object.	Thread.	Time, A. M.	Object.	Thread.	Time, A. M.	Object.	Thread.	Time, A. M.
☉ I	3	^h 7 ^m 52 ^s 5.2	☉ I	3	^h 7 ^m 56 ^s 35.7	☉ I	3	^h 8 ^m 0 ^s 31.8
III	4	52 39.4	III	4	57 11.2	III	4	1 12.8
Ba? I	3	53 0.5	Ba? I	3	31.5	Ba? I	3	27.3
Bb I	3	4.6	Bb I	3	35.8	Bb I	3	31.0
Ba? II	4	18.5	Ba? II	4	57 53.0	Ba? II	4	51.0
Bb II	4	26.7	Bb II	4	58 0.8	Bb II	4	1 59.2
Ba? III	5	35.8	Ba? III	5	13.8	Ba? III	5	2 14.8
Bb III	5	53 48.2	Bb III	5	58 26.8	Bb III	5	2 27.2
☉ I	4	54 55.0	☉ I	4	59 28.6	☉ I	4	3 27.0
II	7	55 12.9	II	7	7 59 44.3	II	7	3 39.9
III	5	7 55 29.8	III	5	8 0 9.1	III	5	8 4 10.0

IV. July 18, after the Eclipse.

No. 1.			No. 2.			No. 3.			No. 4.		
Object	Thread.	Time, A.M.	Object	Thread.	Time, A.M.	Object.	Thread.	Time, A.M.	Object.	Thread.	Time, A.M.
☉ I	1	11 ^h 4 ^m 57.2 ^s	☉ I	3	11 ^h 8 ^m 56.8 ^s	☉ I	3	11 ^h 12 ^m 43.8 ^s	☉ I	3	11 ^h 7 ^m 18.2 ^s
II	3	5 3.7	II	1	9 6.8	II	1	13 10.4	II	1	37.2
III	0	0 28.3	III	0	30.2	III	4	24.7	III	4	17 56.0
Ag I	1	34.4	Ag I	1	43.8	Ba? I	3	36.0	Ba? I	3	18 11.8
Ab I	1	37.8	II	0	9 57.4	Bb I	3	13 40.2	Bb I	3	15.7
Ag II	0	55.9	III	7	10 10.8	Ba? II	4	14 2.3	Ba? II	4	34.0 ²
Ab II	0	5 57.5	D I	3	36.8 ¹	Bb II	4	10.0	Bb II	4	41.8
Ag III	7	6 16.2	II	4	11 13.8	D I	3	23.2	Ba? III	5	57.8
Ab III	7	lost	☉ I	4	45.8	Ba? III	5	29.8	D I	3	18 59.
E I	1	7 9.1 ¹	D III	5	11 53.8 ¹	Bb III	5	14 43.3	Bb III	5	19 9.6
II	0	20.0	☉ II	7	12 1.0	D II	4	15 8.2	D II	4	19 39.8 ¹
III	7	30.8	III	5	11 12 27.1	☉ I	4	39.8	☉ I	4	20 10.8
☉ I	0	7 44.8				D III	5	48.0	D III	5	23.5
II	7	8 7.9						55.7	☉ II	7	23.5
III	5	11 8 18.2							III	5	11 20 57.0

No. 5.			No. 6.			No. 7.			No. 8.		
Object.	Thread.	Time, A.M.	Object.	Thread.	Time, A.M.	Object.	Thread.	Time, A.M.	Object.	Thread.	Time, A.M.
☉ I	1	11 ^h 25 ^m 15.3 ^s	☉ I	3	11 ^h 35 ^m 1.8 ^s	☉ I	3	11 ^h 39 ^m 11.8 ^s	☉ I	3	11 ^h 43 ^m 6.8 ^s
II	3	36.8	II	1	21.6	II	1	28.0	II	1	40.5
III	0	55.8	III	4	35 39.8 ⁴	III	4	39 47.8 ³	III	4	43 51.3
Ab I	1	25 55.8	Ca I	3	36 25.2 ⁴	Bb I	3	40 8.2	Bb I	3	44 3.8
II	0	26 24.8	II	4	37 0.8	II	4	40 33.3	Ca I	3	29.6
III	7	26 52.0	Clouds.			III	5	41 0.4	Bb II	4	37.2
Fa I	1	27 28.2	☉ I	4	37 55.0	Ca II	4	8.5 ²	D I	3	44 47.8 ¹
II	0	38.2	II	7	38 7.0	III	5	41 47.5	Ca II	5	45 0.5
III	7	27 47.8 ³	III	5	11 38 39.8	☉ I	4	42 2.8	Bb III	5	13.0
☉ I	0	28 10.7				II	7	15.8	D II	4	35.2 ¹
II	5	36.1				III	5	11 42 47.6	Ca III	5	45 59.7
III	7	11 28 42.0							☉ I	4	lost
									II	7	46 12.5
									D III	5	46 26.8
									☉ III	5	11 47 0.9

(1) Middle of spot observed.

(2) Observation late.

(3) Instrument unsteady on account of wind.

(4) Clouds.

4. OCCULTATION OF SPOTS. — From 7^h 37^m till 8^h 20^m, observations were made of the passage of the moon's limb over these spots, as also the third of the preceding series of spot-transits. The moment of greatest obscuration passed while I

was thus engaged, but from 8^h 24^m to 8^h 25^m measures of the degree of obscuration were taken. Subsequently the emersions of the spots were noted.

The following are the observed contacts with other spots.

Disappearances.

Reappearances.

Name of Spot.	Mean Time.	Name of Spot.	Mean Time.
Ad	7 37 40.3	A (first appearance of penumbra),	8 29 27.8 ³
Ag	37 49.3	Ab	29 38.2
Ac	38 10.0	A (first appearance of black part),	30 13.0 ¹
A (first contact of penumbra),	38 38.3	A (white crevice),	30 28.9 ⁴
Ab (first contact),	39 25.8	A (complete appearance of penumbra),	31 25.3
Ab (complete disappearance),	40 2.7	Ad (first edge),	38 0 ⁴
A (edge of black part),	12.4	Ad (last edge),	8 31 50.8 ⁴
A (complete disappearance of penumbra),	7 40 45.8	Fb	9 10 48.3 ⁴
E (first contact of penumbra),	8 15 28.5	Fa	9 9 ⁵
E (first edge of black part),	16 4.8	E (first part of large spot),	6 16 55.2
E (complete disappearance of penumbra),	16 25.0	E (second part of large spot),	17 13.9
Fa (first edge — gray),	17 28.7	E (small spot),	9 17 26.3
Fa (second contact),	17 43.2 ¹		
Fb (first edge),	8 19 1.8 ²		

(1) Uncertain.

(2) Somewhat uncertain.

(3) Too late.

(4) Good.

(5) Within about 30'.

The black part of spot *E* was double, the larger part preceding, and the longer diameter of each portion running from northwest to southeast. The white crevice in spot *A* was first seen on the 18th, being on the southeast side.

5. LAST CONTACT.

Limbs apparently in contact,	^h ^m ^s 9 30 49.9
Separation supposed to have occurred,	50.6
“ certainly had occurred,	9 30 53.6

The second of the above was made a fraction of a second later by an independent observation. The point of contact was, as in the ingress, exactly accordant with computation. A power of 64 was used, as at the beginning, a higher power being found to be no improvement. The first and last contact were observed on yellow paper; the transits of spots, on white.

Mr. McDONNELL, observing with the Fraunhofer telescope, noted the last contact a fraction of a second later.

Mr. DEAN, using the theodolite and sidereal chronometer, as before, observed it as 9^h 30^m 49^s.2.

The errors and rates of the chronometers were well determined by Mr. TOOMER, on the nights before and after the

eclipse, with a 26-inch transit-instrument by WURDEMANN, observing 9 zenith and circumpolar stars (with reversal of instrument) on each night. The chronometer-corrections have been applied to the times as given above.

6. PHENOMENA. — The moon's limb was frequently observed to be quite irregular; at 8^h 40 and 9^h it had the appearance of extended table-lands, separated by deep valleys and high mountain peaks. At 9^h 20^m the outline was observed to change considerably, particularly near the western cusp, where the disk apparently became suddenly elongated.

At about 8^h 20^m an appearance was remarked in the southeast limb, which looked upon the screen like a mass of cumulus clouds; the tops illuminated, the bases gray in shadow, and the dark line appearing like the shapes of their bases. The shape and degree of illumination seemed to vary rapidly; this was, however, probably an illusion, as the dark lines were stationary, and their forms persistent under the best illumination. They were repeatedly noticed during the eclipse, and were quite noticeable at 1^h, and, though less marked, were well seen at 1^h 30^m P. M. The next day the dark limbs had opened out into spots.

J. AT BURLINGTON, N. J.

[Extract from a Letter of SAMUEL J. GUMMERE, Esq., to Prof. BACHE, Superintendent.]

My observations of the solar eclipse of the 18th inst., made with a 5-foot equatorial by FITZ, with a power of 120, were as follows: —

	Burlington Time.
	^h ^m ^s
Beginning,	7 6 22
End,	9 5 12

Burlington, 1860, July 24.

	Burlington Time.
	^h ^m ^s
Contact with penumbra of large spot,	7 25 7
“ “ nucleus “ “	7 26 16
Disappearance of do.,	7 27 17

SAMUEL J. GUMMERE.

K. NEAR STEILACOOM, WASHINGTON TERRITORY.

[From the rough Notes of Lieut. GILLISS to Prof. BACHE, Superintendent U. S. Coast-Survey.]

In anticipation of difficulty in obtaining a suitable station on the Cascade Mountains, and because of unfavorable reports respecting the country lying between that range and the Pacific Ocean, two weeks before leaving the Atlantic coast, one of the assistants then on the west coast — Mr. A. T. MOSMAN — was instructed to reconnoitre along the central line to be traversed by the moon's shadow, between Seattle and Steilacoom, and Puget Sound and White River.

As Mr. MOSMAN had not reached Seattle, I proceeded in the steamer to Steilacoom, some thirty-five miles farther south. The U. S. military post of the same name is situated a mile and a half to the eastward of the town, and from its officers much valuable information, and every facility and courtesy, were received.

There were many small open prairies between the Cascade range and Puget Sound, several of which permitted vision of the sun almost, if not actually, upon the horizon. One was selected about ten miles south-southeast from the garrison, and we encamped upon it on the morning of July 9th.

TOPOGRAPHICAL. — The spot was a knoll of slight eminence on Muck Prairie, west of the road, and one mile north of where a stream of the same name crosses it. The surface of the ground is rolling, and the prairie about a mile wide between the eastern and western belts of fir and pine trees. Two hundred yards north of the camp there is a clump of trees, extending three fourths of a mile from the road in a southeasterly direction, — the eastern boundary of this clump being a line nearly north and south.

Between the southeast corner of the clump and the eastern belt bounding Muck Prairie, there is an open space of nearly half a mile, permitting a view in the direction of sunrise. Above the distant fir-belt seen in this last direction, a very slight eminence of the Cascade Mountains is visible, at an elevation of 32' 20" above the ground-line of the prairie, this fir-belt being from four to five miles distant from the camp. Assuming the magnetic variation to be 22° easterly, the bearing of the center of the eminence is N. 64° E., Mount Rainier S. 33° E.

Between the forest bounding the southern side of the prairie and the Cascade Mountains the country is apparently much lower. A part of the mountain range constituting the northern base of Mount Rainier is visible over the eastern fir-belt, and between the southeast by east and south points the entire chain is seen in broken ranges, the nearest of which is estimated to be twenty-five miles distant. The lowest depression in the range is the Cowlitz pass, bearing south-southeast.

After the tents had been pitched under the shadow of the trees near the northwestern angle of the prairie, a computation of the sun's amplitude for the morning of the eclipse showed that the extremity of the northern bounding fir-belt would obstruct the earliest rays. In consequence thereof, a site for the telescopes was selected S. 85° E. and 550 feet distant from the spot on which the observations for time and latitude were made. The site is some ten feet higher than the camp-knoll, and commanded a better horizon in the direction of sunrise. From a mean of all the barometric observations made here, as well as those at camp, and reduced to 32°, and upon the assumption that the barometer at the level of Puget Sound stands at 30", the elevation is about 360 feet. Under the spot on which the comet-seeker was mounted, a bottle containing a paper with a suitable inscription was subsequently buried, and a mound of stones, three feet high, erected thereupon. The site is well known to persons at Steilacoom, as well as to the occupants of the adjoining farm. Circum-meridian altitudes of the sun, *α Ophiuchi*, and *α Aquilæ*, and of *α Ursæ Minoris* near its greatest eastern elongation, were observed at camp with a prismatic sextant and artificial horizon, and the local time was determined with the same instruments.

ECLIPSE. — For the first time after our arrival at the station selected, the sun rose clear on the morning of the 17th; nor was there at any time during the day more than two tenths of the sky obscured by clouds.

By 3½ A. M. we had removed the meteorological instruments from camp to the telescope knoll. At that time it was sufficiently light to write without artificial aid. Mount Rainier was distinctly visible, and sharply cut against the southeastern sky. Beyond it, and toward the point at which the sun would rise, there was a stratum of vapor, whose upper line was slightly inclined from mid-height of Rainier towards the northern horizon. At that time the barometer stood at 29".698; attached thermometer, 44°.5; the temperature of the air was 45°.2, and there was only a very slight air from the southward.

At 4^h 6^m the mist-striæ became denser to the northward and eastward, and were more evidently in rays diverging from the point of sunrise to an elevation of some 25°. The air was so cool and so loaded with moisture, that, although the telescopes had been out all night, the object-glasses were densely covered with dew immediately after the caps were removed. By 4^h 19^m a part of the vapor to the northward and eastward

had condensed into little cumuli, beyond the Cascade range, each more light and feathery with distance from the diverging point, though none of this series extended so far as Mount Rainier, and it was only towards the Cowlitz pass that a dense volume of vapor could be seen pouring in towards the lower lands bordering on Puget Sound. Two minutes later, and the edges of the little flocculi were tipped with pink and golden hues, increasing in brilliancy of color as the sun approached the horizon.

The eclipse had far advanced when the first cusp appeared above the horizon at 0^h 39^m 38^s by chronometer. It was seen through a red screen-glass, and was sharp, and without tremor. Indeed, the atmosphere was so still that the rise of the second cusp over the distant ground-line, at 0^h 40^m 58^s, was observed with the precision of a transit of a limb over the wire of a telescope. But it was at once perceived that there was great distortion of the lune, the lower half being flattened by the unequal refraction.

At this time I was again obliged to wipe the heavy drops of dew from the object-glass of the telescope, and while so doing my attention was directed to the vapor near us. The whole northeastern portion of the prairie had apparently been converted into a placid lake, with here and there a knoll projecting through, and forming a miniature isle; the illusion being enhanced by rapidly diminishing intensity of the light. At 4^h 43^m distant objects could not be recognized more distinctly than during midsummer twilight at 8½ P. M.

At 4^h 44^m the southern cusp had become rounded off, and jagged, as though the moon's edge was serrated. But had such been the case, this portion of the lune would have broken into beads of light before the total obscuration took place, and this did not occur, the moon's disk equally and uniformly interposing between us and the sun, until the last glimmer of light disappeared.

I had turned off the red screen half a minute before, and was surprised to behold quite distinctly the following segment of the lunar sphere. The periphery of this segment was more than 100°. Its color was uniformly shaded, from an intense black at the center of the lunar disc, to a very dark grayish-purple near the limb of the sun. It was still traceable during 20^s after the last glimmer of sunlight.

At the moment of totality, beads of golden and ruby-colored light flashed almost entirely around the moon, not constant even for a second at one point, but fitfully flashing, as a reflection from rippled water, and as unstable in the respective places of the colors. This bead-thread could not have extended more than 10" or 12" beyond the lunar disk. It broke up suddenly at 1^h 16^m 21^s.2, Sid. Chron., and then, for the first time, protuberances were noted beyond the following limb of the moon. The position of the largest one was N. 75° or 78° W., and in the form of a flattened cone or pyramid of cumulus clouds, about 1' in height, and, when first observed, perhaps 2' broad at the base. The cloud was not a uniform mass, but apparently an aggregation of small ones. Its general tint was

a rosy pink, with occasional spots and edges of yellowish-white light, as though sunlight shone obliquely through them. Except in the pink color, it greatly resembled the protuberance noted during the total eclipse of the sun observed at Olmos, 1838, September 7. As the moon advanced, this protuberance was notably broader at its base and brighter at its summit, whilst its elevation apparently remained the same. This was an extremely beautiful object to look upon, and I watched it closely, giving nearly all my attention to it during 15^s; yet at the same time was able to perceive a smaller one of a more flattened appearance, distant 10° or 15° towards the west, and several others yet smaller, and of a much darker color, at different points of the disk. At a later period a continuous chain, more than 30° in extent, and more than 30'' high, was noted on the southeast border. Intently occupied with the great protuberance, the corona had not been recognized up to this instant (0^h 58^m 10^s), interest in the former also causing me to drop the beat of the chronometer.

It was then so dark that I found it impossible to recognize the second-dial of the gold chronometer, and Mr. JAS. GILLISS was called to bring his lantern, and record the time at which I should indicate the second internal contact of the limbs. Lifting my face from the box on which the time-keeper stood to the telescope, a most extraordinary scene was apparent! Over the moon's black disk colors of the spectrum flashed in intersecting circles of equal diameter with that body; and each apparently revolving toward the lunar center. These moving colors were not visible beyond the moon, but a halo

of virgin white light encircled it, which was quite uniformly traceable more than a semidiameter beyond the black outline. This corona was composed of radial beams or streamers, having slightly darker or fainter interstices, rather than of a disk of regularly diminishing or suffusing light. But the gorgeous appearance of the spectrum circles, with their incessantly changing bands of crimson, violet, yellow, and green, thoroughly startled me from the equanimity with which the preceding phenomena had been observed. Nor were these colors physiological results from a change of position of the body, or of preceding strain of sight in efforts to recognize the divisions on the second-dial in darkness, and subsequent sudden direction of the eye towards the sunlight; for they continued visible with the telescope at least 10^s longer. As near as it was possible to estimate, the breadth of each spectrum-circle was about 2'. The green colors were not darker than the tint usually called pea-green, and were on the edges farthest from their respective centers; but neither of the hues seemed to retain a definite position, and I was irresistibly drawn to their contemplation, to the neglect of all the changes that might have been taking place in the protuberances and corona.

They vanished with the first appearance of sunlight, beyond the western limb of the moon, their sudden obliteration causing me to utter an exclamation, which was regarded as a signal for noting the time, a datum whose importance had been wholly forgotten in the fascination they caused. I cannot liken them to anything so near as the kaleidoscope.

J. M. GILLISS.

ON BIELA'S COMET.

By PROFESSOR J. S. HUBBARD,

OF THE WASHINGTON OBSERVATORY.

(Continued from page 112.)

III.

§ 1.

It is immediately obvious, upon considering the relations of this comet's orbit to those of the planets which chiefly disturb it, that any attempt at a determination of its general perturbations would be, in the present state of theory, entirely premature. In aphelion, the comet passes just beyond and above the orbit of *Jupiter*, and, for two or three years, remains at an average distance of only unity from it, so that, should the planet be also in the same neighborhood, it would cause great perturbations of node and inclination, as was the case between 1772 and 1806, when the former element was changed from 257° 41' to 251° 16', and the latter from 17° 3' to 13° 37'. Again, the comet's path at the descending node passes very near, and at times, as between 1826 and 1832, even intersects the orbit of the earth, rendering possible an actual collision of the two bodies, or, escaping this, a complete transformation of the comet's orbit. The only prospect that has yet appeared

of treating with success this complicated problem, seems to lie in a more complete development of HANSEN's method of "partial anomalies,"⁽¹⁾ placing the "points of separation" not only in the orbit of the comet, but also in that of the earth.

But even should this method prove practicable hereafter, its application must be preceded by an extensive calculation of special perturbations, for the purpose of obtaining osculating elements of sufficient accuracy, and for this work the rectangular-coördinate method of BOND and ENCKE especially commends itself by its simplicity, and by the facility with which, in its latest form,⁽²⁾ account can be taken of all sensible terms of every order in the perturbations, excepting only the present unavoidable effect of the uncertainty in the assumed planet-masses and planet-places.

⁽¹⁾ *Mémoire sur le Calcul des Perturbations qu'éprouvent les Comètes.*

⁽²⁾ *Berl. Astr. Jahrb., 1858, Anhang.*

The separation of the comet into two parts marks an epoch in its history, on either side of which an independent treatment of the differentials is requisite, since it is probable, *a priori*, that an orbit which represents the observed places of the comet when single will, if continued beyond the point of separation, fall between or within the orbits of the two nuclei, rather than coincide with either. In the present memoir I have commenced with the observations in 1845-46, immediately subsequent to the disruption, and, connecting these with the few obtained in 1852, by a calculation of perturbations which I have sought to render perfectly accurate, have then determined for each nucleus new elements, which will serve as the basis of prediction for the coming appearance in 1865-66.

§ 2.

It is by no means essential, in order to an accurate determination of perturbations during the first period, that the question of identity should be decided, since in both hypotheses there is, in 1847, a common starting-point, from which the paths of either nucleus to the observed places in 1852 are almost identical. The elements here adopted as provisional are those given for 1846, in the preceding memoir, and there denominated III. 2 and C.⁽¹⁾ For the planet-masses I have assumed the following values:—

Planet.	$\frac{1}{m'}$	$\log m'$
<i>Mercury</i> ,	4865751	3.31285
<i>Venus</i> ,	401839	4.39595
<i>Earth</i> ,	355499	4.44916
<i>Mars</i> ,	3200900	3.49473
<i>Jupiter</i> ,	1047.871	6.979692
<i>Saturn</i> ,	3501.6	6.455733
<i>Uranus</i> ,	24905	5.60371

Commencing at the perihelion in 1846, I now computed for each nucleus, with 4-day intervals, the perturbations produced by all the planets, from *Mercury* to *Saturn* inclusive, until 1846, April 24, when the comet's distance from the sun was 1.38; then reducing the elements to the center of gravity of *Sun* and *Mercury*, I proceeded with 12-day intervals as far as 1847, February 18, when the value of r was 3.9. At this point the elements were transferred to the center of gravity of *Sun*, *Mercury*, *Venus*, and *Earth*, and then the motion of the comet being sufficiently slow, and not too variable, the calculation progressed with intervals of 32 days, including the effect of *Mars*, *Jupiter*, *Saturn*, and *Uranus*, through the aphelion to 1851, September 9, when the radius-vectors were again 3.9, from which point the work was extended in reverse order over the remainder of the period.

Seeking to avoid the dangerous cumulative errors incident to the double integrations, I have, in computing the differentials, aimed at accuracy in the tenth place of decimals, and although small uncertainties have doubtless crept into these extended calculations, yet I believe that the final accuracy is

still fully as great as the assumed planet-data are competent to insure, while the independent computation for each nucleus has doubtless guaranteed against sensible constant error.

The results of the separate divisions of the work, transformed into variations of elements and collected together, give the following as the effect of perturbations from 1846, February 11, to 1852, September 23:—

	Preceding Nucleus.	Following Nucleus.	Precession, from 1846.0 to 1852, Sept. 23.
δM	—2621.398	—2620.294	
$\delta \Omega$	—480.514	—479.787	+351.621
$\delta \omega$	+502.431	+501.809	—13.897
δi	—95.379	—95.378	—0.959
$\delta \varphi$	—236.309	—236.234	
$\delta \mu$	—1.417326	—1.415430	

§ 3.

With these values of the perturbations, Elements III. 2 and C, corresponding to the first hypothesis of identity, give, when compared with the normals in 1852, the following residuals:—

	III. 2.		C.	
	$\Delta u \cos \delta$	$\Delta \delta$	$\Delta u \cos \delta$	$\Delta \delta$
1852, Aug. 28			+250.9	—98.9
Sept. 21	+215.7	—110.2	+219.5	—112.9

Combining these with the residuals given, with the same elements, by the normals in 1845-46, and quoted in the preceding memoir,⁽²⁾ I obtained the corrected elements given below under Hypothesis 1.

For the second Hypothesis, I assumed in elements III.⁽³⁾ the approximate value of $\Delta u = +0''.49161$, and applied to the resulting provisional elements for the principal nucleus the differences $M' - M$, $\Omega' - \Omega$, &c.⁽⁴⁾ to obtain corresponding values for the secondary. These elements, compared with the normals for 1845-46 and 1852, gave:—

		PRINCIPAL.		SECONDARY.	
		$\Delta u \cos \delta$	$\Delta \delta$	$\Delta u \cos \delta$	$\Delta \delta$
1845, Dec.	1	+1.5	+3.4		
	27	—0.2	—8.8		
1846, Jan.	16	+2.2	—2.3		
	24	—0.2	+0.2	0.0	+2.1
Feb.	5	+2.2	+0.4	+1.9	+1.5
	17	+0.7	+2.2	+0.9	+1.4
	25	+1.5	+4.6	+1.8	+5.9
Mar.	5	+2.1	+2.7	+0.3	+3.0
	13	+2.1	+4.3		
	21	+0.7	+2.7	+0.4	+3.2
	29	+1.8	+1.4		
Apr.	18	+5.2	—23.5		
1852, Aug. 28		+7.0	+4.4		
Sept. 21		+10.3	—1.3	+3.9	—1.0

(1) *Astr. Journal*, VI. 131.(2) *Ibid.*, VI. 137.(3) *Ibid.*, III. 90.(4) *Ibid.*, IV. 4.

The normal of 1845, December 1, was not used in the subsequent operations, but only retained for comparison. Moreover it was found on trial that the place of 1846, April 18, could not be introduced without prejudice to the rest, the re-

Greenwich Mean Time. Mean Equinox 1846.0.

HYPOTHESIS I.

Principal Nucleus in 1846 = Preceding in 1852.

IV_I	D_I
$0^{\circ} 0' 3.631$	$359^{\circ} 59' 18.963$
327 3 49.266	327 3 48.163
139 36 44.103	139 36 49.449
21 27 11.387	21 27 9.060
49 10 17.048	49 9 59.424
537".34639	537".51499
Feb. 10.99324	Feb. 11.07635
$245^{\circ} 54' 19.10$	$245^{\circ} 54' 8.27$
223 8 33.06	223 8 47.94
12 34 54.86	12 34 55.00

HYPOTHESIS II.

Principal Nucleus in 1846 = Following in 1852.

IV_{II}	D_{II}
$0^{\circ} 0' 3.872$	$359^{\circ} 59' 18.701$
327 3 54.535	327 3 41.554
139 36 41.089	139 36 53.463
21 27 11.571	21 27 9.562
49 10 2.736	49 10 13.673
537".496479	537".364981
Feb. 10.99280	Feb. 11.07685
$245^{\circ} 54' 20.93$	$245^{\circ} 54' 9.35$
223 8 33.18	223 8 44.77
12 34 52.97	12 34 57.46

RESIDUALS. (C. — O.)

$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha'$	$\Delta\delta'$		$\Delta\alpha$	$\Delta\delta$	$\Delta\alpha'$	$\Delta\delta'$
(+2.1	+ 7.7)			1845, Dec. 1	(+0.5	+ 5.6)		
—0.6	— 6.1			27	—0.8	— 7.4		
+1.2	— 0.9			1846, Jan. 16	+2.0	+ 1.6		
—1.3	+ 1.1	—0.1	—1.1	24	—0.3	+ 0.7	—1.1	+0.2
+1.2	+ 0.3	+1.8	—1.7	Feb. 5	+2.0	+ 0.1	+1.1	—0.9
0.0	+ 1.1	+0.3	—2.0	17	+1.0	+ 1.1	—0.1	—1.4
+1.0	+ 2.7	+0.8	+2.7	25	+1.4	+ 2.9	+0.9	+2.7
+1.3	+ 0.1	—0.8	—0.2	Mar. 5	+1.5	+ 0.5	—0.3	—0.4
+1.0	+ 0.8			13	+0.4	+ 1.4		
—0.7	— 1.3	+0.2	+0.2	21	—1.8	— 0.5	0.0	—0.5
—1.0	— 2.8			29	—1.5	— 2.3		
(+1.2	—27.3)			Apr. 18	(+2.3	—27.1)		
		+0.2	+5.0	1852, Aug. 28	+0.2	+ 7.5		
+1.3	+ 2.1	+2.2	—0.3	Sept. 21	+4.2	+ 1.3	0.0	+0.1

From these results it is immediately apparent that, so far as the representation of the observations is concerned, there is still no choice whatever between the two hypotheses. Or, if there should seem to be a slight leaning in favor of the first, there is at least as much evidence for the other in the physical fact that the southern and following nucleus, in 1852, was first found and oftenest observed, and we are therefore compelled to wait until another return to the perihelion shall settle this question of identity, and enable us to proceed with a strict determination of the perturbations.

§ 4.

A general investigation of the relative distances of the two comets shows that there is always a maximum at or near the perihelion, and a minimum not far from the opposite extremity of the orbit. The following numbers, extracted from a more extended table, will indicate sufficiently the more precise location of some of these maxima and minima, with their approximate magnitudes. The argument here, r_0 , is the average true anomaly of the nuclei, and is counted from the perihelion in 1846.

r_o	t	Δ	r_o	t	Δ
	^d	I		^d	I
—540	—3617	0.00429	0	0	0.00203
530	3310	377	+10	+6	203
520	3052	453			
—370	—2417	0.02058	+110	+321	0.00082
360	2411	2067	150	451	77
350	2405	2060	160	641	89
—160	—641	0.00078	+350	+2405	0.01655
150	451	62	360	2411	1661
140	321	68	370	2417	1654
—10	—6	0.00202	+520	+3052	0.00385
0	0	203	530	3310	339
			540	3617	401
		II			II
		0.00297			0.00207
		251			206
		289			
		0.01242			0.00081
		1247			73
		1242			79
		0.00071			0.01654
		68			1661
		77			1655
		0.00206			0.00378
		207			313
					349

The minima immediately preceding and following the perihelion in 1846 are generally, from the nature of the case, the points of closest possible approach of the two comets, and of these minima the first is the smaller. While, then, they have passed the second without sensible mutual disturbance, it seems difficult to imagine that the separation, however caused, could have occurred at any other point than in the neighborhood of the first, that is, in heliocentric longitude $318^{\circ}.6$, latitude $+12^{\circ}.0$, distance 4.36, which place the comets occupied in November, 1844.

FIFTY-NINTH ASTEROID.

CIRCULAR. — Cambridge, 1860, September 19.

LETTER FROM MR. FERGUSON TO THE EDITOR.

Washington, 1860, September 16.

I DISCOVERED last night a new Asteroid, of which the observed place is approximately as follows:—

Washington Mean Time.			α	δ
^h	^m	^s	^h	^m
10	22	5	23	4 30.4
				—3 23 39"

Its daily motion is -54.0 in right ascension and -9.0 in declination.

I had noted it on the night of the 14th, as one not on CHACORNAC'S Charts; last night its planetary character was quite evident.

JAMES FERGUSON.

Commander MAURY has sent the following additional positions of this fifty-ninth asteroid, which Mr. FERGUSON estimates as of the 11 magnitude.

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	Planet — *	Planet's apparent
	^h ^m ^s			α δ	α δ
1860, Sept. 15	9 39 14.2	10	B. A. C. 8084	—2 21.27	+0 19.50
16	8 29 50.9	6	B. A. C. 8084	—3 12.49	—6 37.75
21	8 28 45.4	7	* 12	+1 56.41	+8 27.47
					22 59 24.26
					—4 5 41.59

Mean Places. for 1860.0. of Comparison-Stars.

*	Mag.	α	δ	Authority.
B. A. C. 8084	6	^h ^m ^s	^h ^m ^s	
* 12 ⁽¹⁾		23 6 54.19	—3 23 42.76	α Y. 1. δ Y. 3.
		22 57 23.42	—4 14 35.91	Washington Equatorial.

⁽¹⁾ The place of * 12 depends upon a single comparison.

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ON BIELA'S COMET, BY PROFESSOR J. S. HUBBARD.

FIFTY-NINTH ASTEROID.

THE ASTRONOMICAL JOURNAL.

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CAMBRIDGE, 1860, NOVEMBER 13.

NO. 21.

OBSERVATIONS OF TITANIA.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — Corrected for refraction.]

Date.	Washington M. T.	No. of Comp.	Comparison-Star.	⁽⁶⁰⁾ — *		α	δ
				Δa	$\Delta \delta$		
1860, Sept. 15	^h 9 ^m 39 ^s 14.3	10	B.A.C. 8084	—1 ^m 21.28	+ 0 ^s 19.50	^h 23 ^m 4 ^s 37.28	—3 [°] 22' 56.84
16	8 29 50.9	6	" 8084	—3 12.48	— 6 37.75	23 3 46.07	3 29 54.00
21	8 28 45.4	7	* 12	+1 56.41	+ 8 27.47	22 59 25.81	4 5 59.51
22	8 12 5.9	20	"	+1 7.03	+ 1 29.65	58 36.42	4 12 57.31
22	8 49 30.2	4	"	+1 5.63	+ 1 23.96	58 35.03	4 13 3.00
23	8 10 26.6	20	"	+0 17.22	— 5 22.27	57 46.61	4 19 49.22
25	7 40 35.7	4	"	—1 16.73	—18 49.05	56 12.68	4 33 15.95
28	8 30 20.1	4	Σ . Cat. Gen.	+1 23.44	+12 49.85	53 54.03	4 53 28.42
29	8 10 20.1	8	"	+0 40.27	+ 6 25.89	53 10.86	4 59 52.46
Oct. 5	11 27 10.5	6	B.A.C. 7993	—0 52.09	— 3 32.74	49 14.40	5 36 34.73
6	7 26 36.3	14	" 7986	+0 45.19	+ 2 15.00	48 44.87	5 41 17.35
10	8 41 42.2	13	Weisse, XXII. 957	+0 30.06	+ 3 3.03	46 44.23	6 1 40.55
12	8 34 30.4	9	" 957	—0 20.92	— 6 12.06	45 53.23	6 10 55.60
16	8 39 8.6	7	" 897	+1 28.57	— 5 57.10	22 44 31.56	—6 26 6.45

Mean Places for 1860.0 of Comparison Stars.

Star.	Mag.	α	δ	Authority.
B.A.C. 8084	7	^h 23 ^m 6 ^s 54.18	—3 [°] 23' 42.76	Y ¹ , Y ² .
* 12	9	22 57 25.01	4 14 53.04	Y ¹ , L ¹ .
Σ Catal. Gen.	8	22 52 26.21	5 6 44.08	Y ¹ , L ¹ .
B. A. C. 7993	7	22 50 2.13	5 33 27.45	} British Association Catalogue.
B. A. C. 7986	7	22 47 55.33	5 43 57.67	
Weisse, XXII. 957	9	22 46 9.84	6 5 8.50	} Weisse's Catalogue.
" " 859	9	22 42 58.67	—6 20 33.85	

In consequence of the discovery, by Mr. CHACORNAC, on the 12th September, the planet discovered at Washington becomes the *sixtieth*. It is proposed, with the consent of astronomers, to name it *Titania*.

Washington, 1860, October 18.

ELEMENTS OF TITANIA.

FROM LETTERS OF MR. FERGUSON TO THE EDITOR.

I have computed the accompanying Elements of the Sixtieth Asteroid from observations of September 15, 22, and 29:—

$$\begin{aligned}
 T &= 1860, \text{ Oct. 1, Washington M. T.} \\
 M &= 197^{\circ} 28' 55.9. \\
 \pi &= 158 \quad 5 \quad 38.6 \\
 \Omega &= 187 \quad 12 \quad 10.3 \\
 i &= 4 \quad 41 \quad 4.4 \\
 \varphi &= 11 \quad 27 \quad 27.0 \\
 \log a &= 0.359763 \\
 \log \mu &= 3.010362
 \end{aligned}
 \left. \begin{array}{l} \\ \\ \\ \\ \\ \\ \\ \end{array} \right\} \text{Mean Equinox of Epoch.}$$

1860, October 28.

I send the annexed improved elements, which, though not yet quite correct, are nearer than those sent before. I have

not been able to find time to make an Ephemeris, but will do so soon.

$$\begin{aligned}
 T &= 1860, \text{ Oct. 1, Washington M. T.} \\
 M &= 199^{\circ} 48' 13.8 \\
 \pi &= 158 \quad 6 \quad 45.7 \\
 \Omega &= 187 \quad 15 \quad 15.8 \\
 i &= 4 \quad 40 \quad 18.8 \\
 \varphi &= 11 \quad 27 \quad 10.2 \\
 \log a &= 0.359725 \\
 \mu &= 1024''.3
 \end{aligned}
 \left. \begin{array}{l} \\ \\ \\ \\ \\ \\ \\ \end{array} \right\} \text{Mean Equinox of Epoch.}$$

JAMES FERGUSON.

ON THE SUPPOSED INTRA-MERCURIAL PLANETS.

By SIMON NEWCOMB.

A VERY simple computation will show that a planet of the same reflective power with *Saturn*, and of $\frac{1}{400}$ part his diameter, placed at the distance 0.15 from the Sun, would at quadrature glow with about the same brilliancy as *Saturn* does at opposition. The bulk of such a planet would be $\frac{1}{64000000}$ that of *Saturn*; and if its density were 120 times as great, it would still have only $\frac{1}{5000000}$ of his mass. A planet at this distance would require $\frac{1}{650}$ the mass of *Saturn* to produce the motion in the perihelion of *Mercury* indicated by the researches of LEVERRIER. The further the planet should be from the Sun, the less the mass which would be necessary, and the more easily it would be found.

It is incredible that a group of planets each as bright as *Saturn* at opposition, surrounding the Sun, should not have been observed during total eclipses, if they existed. I think, therefore, that we are justified in concluding that, if the observed motion in the perihelion of *Mercury* is caused by intra-Mercurial planets, they must be several hundred in number.

From what has been said it would seem that five hundred would be a very moderate estimate of the number of the intra-Mercurial planets; and if so numerous, it is evident from the following table, that, unless their inclinations be enormously great, there must be a transit nearly every day. They may well be so minute as to escape observation entirely with ordinary instruments, and that mode of looking for them which gives most hope of success is to examine the sun carefully with very high powers.

To estimate as well as possible the number of these occurrences, I have prepared the following table, giving the number of transits in ten years of planets of different mean distances and inclinations. It is founded on the fact that a planet of any given mean distance and inclination will, on the whole,

transit the disk of the Sun with a certain frequency, depending on the values of those elements. Strictly speaking, this frequency would be slightly affected by the eccentricity, but as the change would only be of the second order with respect to that element, it is neglected.

Table showing the number of Transits in ten Years of Planets having different Mean Distances and Inclinations.

<i>i</i>	Mean Distance.				
	.10	.15	.20	.25	.30
0°	306	162	102	70	51
1°	306	162	102	41	21
2	306	88	36	18	10
3	181	53	23	12	7
4	126	37	18	8	5
5	98	31	14	7	5
6	79	24	12	6	4
7	67	21	10	6	3
8	50	19	9	5	3
9	55	18	8	4	2
10	48	17	8	4	2
11	42	16	7	4	2
12	38	14	6	3	2
13	36	12	6	3	1
14	34	11	5	3	1
15	32	10	5	2	1
16	30	10	4	2	1

Whatever motion of the perihelion of *Mercury* might be produced by the action of a numerous group of asteroids, it is easily deducible that nearly the same amount of motion would be produced in its node, supposing that each asteroid is very small compared with the sum of all the others. This results from the circumstance that the invariable plane of the planetary

system will always be very near the probable mean position of the orbits of a numerous group of planets at any time. This may be shown as follows.

If we obtain the general expressions for the inclination and

$$\begin{aligned}\sin i \sin \Omega &= \varepsilon \sin (kt + \beta) + \varepsilon_1 \sin (k_1 t + \beta_1) + \dots + E \sin (Kt + B) \\ \sin i \cos \Omega &= \varepsilon \cos (kt + \beta) + \varepsilon_1 \cos (k_1 t + \beta_1) + \dots + E \cos (Kt + B) \\ \sin i' \sin \Omega' &= \varepsilon' \sin (kt + \beta) + \varepsilon'_1 \sin (k_1 t + \beta_1) + \dots + E' \sin (K't + B') \\ \sin i' \cos \Omega' &= \varepsilon' \cos (kt + \beta) + \varepsilon'_1 \cos (k_1 t + \beta_1) + \dots + E' \cos (K't + B').\end{aligned}$$

In these expressions the quantities ε , ε_1 , &c. are all very small, and if E , E' , &c. also be small, it is evident that the inclinations will always be included within narrow limits. But, in order that the asteroids should have no influence in changing the node of *Mercury*, it is requisite that the mean positions of the planes of their orbits should not differ from the plane of

$$\frac{d\theta}{dt} = - \{ (0.1) + (0.2) + (0.3) + \dots \} + (0.1) \frac{\tan i'}{\tan i} \cos (\theta - \theta') + (0.2) \frac{\tan i''}{\tan i} \cos (\theta - \theta'') + \dots \quad (2)$$

If now the inclinations of the orbits of the disturbing bodies are considerable, E , E' , &c. must be considerable in comparison with the ε s. If the bodies are very numerous, several hundred in number, it will follow from the theory of probabilities that we may expect to find the angles $Kt + B$, $K't + B'$, &c. pretty evenly distributed throughout the circle. It is true that there is no physical necessity that they should be thus distributed; still, the probability against it is so small, that it would be entirely neglected in the ordinary concerns of life. But it is easy to see that, in the case I have supposed, these angles would represent approximately the longitudes of the nodes; therefore we are to expect that on the invariable plane the nodes will also be nearly evenly distributed in longitude. Again, there being no relation between the nodes, the inclinations, and the masses, and the angles $\theta - \theta'$, $\theta - \theta''$, &c. being nearly evenly distributed, it is in the highest degree probable that the second part of (2) will be very small in comparison

node of an asteroid during all time by the method of LAGRANGE developed in the *Mémoires de Berlin*, 1781-2, and since explained by LAPLACE, PONTECOULANT, LEVERRIER, and JACOBI, they will be of the form

the orbit of *Mercury*, and the latter planet having a large inclination, this condition cannot be fulfilled if the inclinations of the asteroids are small.

Let us now take the expression given in the *Mécanique Céleste*, Liv. II., No. 60, for the secular variation of the node of a planet.

with the first part, which will, therefore, very nearly represent the motion of the node of *Mercury*, produced by the intra-Mercurial planets. But this part is also the expression for the motion of the longitude of the perihelion, when the eccentricities are neglected, their effect being supposed to cancel each other, like those of the inclinations. The motion of the node on the ecliptic will be about $\frac{1}{3}$ less than on the invariable plane; we are, therefore, justified in concluding, that, if the motion of 38 seconds per century in the perihelion of *Mercury* is produced by a group of intra-Mercurial planets, the planets must also produce a retrograde motion of about 34 seconds in the node of *Mercury*.

It will, of course, be remembered, that this conclusion is founded on the hypothesis, reasons for which have been given, that each separate planet of the group is very small in comparison with the sum of the others.

THE SOLAR ECLIPSE IN WASHINGTON TERRITORY.

FROM THE REPORT OF LIEUT. GILLISS.

[Communicated by Prof. A. D. BACHE, Supt. U. S. Coast Survey.]

THE latitude of the station was determined from circum-meridian altitudes of the *Sun*, *Polaris*, and *Altair*, measured with a sextant and artificial horizon, as follows:—

1860, July 13,	5 observations sun's lower limb,	+47° 2' 26.2"
" " 16, 5	" Polaris	3 11.2
" " 18, 8	" Altair	3 4.4
Mean by weight,		47 2 54.1

The camp knoll was 47 feet north of that on which the eclipse was observed, and the latitude adopted is +47° 2' 54".

Neither of the chronometers was uniform in its rate. No. 2113 left New York with a daily gaining rate of 0.2. From July 13th to July 18th, the observed rate was losing 3.31; and during the whole time it was absent from New York it lost 0.95 per day.

No. $\frac{2}{739}$ on leaving New York gained 0.5 per day; its rate in camp was losing 0.62, and for the whole absence losing 2.09 per day.

The chronometric results for longitude are therefore:—

Chronometer.	From the rate of May 21.	From rate of July 13-18.	From rate of May 21 - Aug. 24.
	h m s	h m s	h m s
No. 2113,	8 11 16.44	8 9 8.33	8 10 33.89
No. $\frac{2}{739}$,	8 12 2.24	8 11 22.56	8 10 26.41
Means,	8 11 39.34	8 10 15.44	8 10 30.15

The correction applicable to observations at camp to reduce them to the telescope knoll being -0.56, if we adopt the determination from the rates between 21st May and 24th August

as the most reliable, we shall have for the spot on which the eclipse was observed, longitude $8^h 10^m 29.6$ west.

In obtaining the times for the phases of the eclipse, I have used a mean of the chronometer errors from observations of the sun's upper limb on the morning and afternoon of July 18th, and the mean rate derived from errors on the morning of 13th and afternoon of 18th July. The observations thus corrected give the following results : —

	h	m	s
Immersion of spot,	4	38	41.3
First internal contact of limbs,	4	47	29.9
Second internal contact of limbs,	4	49	25.3
Duration of total eclipse,	2	55.4	
Emersion of spot,	5	30	6.4
End of eclipse,	5	42	28.2

FROM A LETTER OF MR. LIAIS TO THE EDITOR.

Rio de Janeiro, 1860, August 24.

I HAVE the honor to send you the observations made on the third comet of 1860 by the Scientific Commission, which the Brazilian government has placed under my charge.

The positions obtained are as follows : —

Dat	Rio de Janeiro Mean Time			α			δ		
	h	m	s	h	m	s	°	'	"
1860, July 8,	6	44	8.3	9	47	39.91	+19	31	3.7
13,	6	50	53.4	10	47	3.64	+2	41	8.5
14,	6	56	32.5	10	57	40.90	—0	34	53.7
15,	6	52	8.7	11	7	40.58	3	40	21.7
17,	6	55	32.9	11	26	22.21	9	24	20.7
18,	7	17	37.2	11	35	14.26	12	3	2.9
23,	8	15	36.4	12	13	6.11	—22	29	43.3

By the means of these observations I had already computed a parabolic orbit, and communicated it to the *Astronomische Nachrichten*, when the scientific journals apprised me that the comet had been observed in Europe on the 22d of June, and brought me an observation made on that date at Paris.

I have combined the Paris observations with ours to rectify the first elements, and have found that an elliptic orbit would represent the observations much better. The elliptic elements at which I have arrived are these : —

ELLIPTIC ELEMENTS.

Perihelion-passage,	June 15.8936479, Rio de Jan. M.T.
Perihelion-distance,	0.2921259
Eccentricity,	0.997240
Semixaxis major,	105.84
Period,	1088 ^s .9
Inclination,	79° 17' 38"
Longitude of Asc. Node,	84 42 50.0
Perihelion,	161 21 9.5

Mean Equinox of 1860, Jan. 1.

EMM. LIAIS,

President of the Scientific Commission charged by the Brazilian Government with the Revision of the Charts of the Coast of the Empire.

FIFTY-NINTH, SIXTY-FIRST, AND SIXTY-SECOND ASTEROIDS.

THE *fifty-ninth* asteroid was discovered by Mr. CHACORNAC, at Paris, September 12, being of a bright 10 magnitude.

The following observations have been published by Mr. LEVERRIER and Prof. PETERS : —

Date.	Place.	M. T. of Place. h m s	(59) α h m s	(59) δ ° ' "
1860, Sept. 12	Paris,	13 43 28.1	0 39 34.72	
12	"	13 46 8.7		+1 9 25.9
13	"	14 3 43.6		+1 0 35.8
13	"	14 27 55.0	38 58.49	
17	Vienna,	9 14	36 39	+0 25
17	Bilk,	11 15	36 39	+0 25
20	"	10 40	34 37	—0 2
23	"	12 25	32 27	—0 31
24	Altona,	11 1 12.6	31 47.33	—0 39 14.0
25	"	10 14 19.4	0 31 5.60	—0 48 18.9

Mr. W. ELLIS, of Greenwich, had computed approximate elements.

ELEMENTS OF THE FIFTY-NINTH ASTEROID.

1860, Sept. 15, Greenwich M. T.

$$\begin{aligned} M &= 15^{\circ} 51' 43'' \\ \pi &= 337 \ 51 \ 49 \\ \Omega &= 167 \ 8 \ 47 \\ i &= 6 \ 35 \ 55 \\ \varphi &= 11 \ 19 \ 18 \\ \log a &= 0.415861 \\ \mu &= 8.43''.753 \end{aligned} \quad \left. \begin{array}{l} \\ \\ \\ \\ \end{array} \right\} \text{Mean Eq. 1860.0}$$

An ephemeris, deduced from these elements, and found to be still correct, on the 25th September gave the following apparent path for the planet during the month of October.

Date.	App. α	App. δ	Log $\triangle$	Date.	App. α	App. δ	Log $\triangle$
1860, Oct. 1	^h 0 ^m 26 ^s 38.7	[°] —1 ['] 43.8		1860, Oct. 16	^h 0 ^m 16 ^s 55.9	[°] —3 ['] 29.0	
2	0 25 55.4	1 52.7		17	0 16 24.4	3 45.1	
3	0 25 12.6	2 1.4	0.0592	18	0 15 54.5	3 50.9	0.0834
4	0 24 39.2	2 9.9		19	0 15 26.0	3 56.5	
5	0 23 47.9	2 18.3		20	0 14 58.7	4 1.8	
6	0 23 6.5	2 26.5	0.0625	21	0 14 32.9	4 7.0	0.0902
7	0 22 25.7	2 34.6		22	0 14 8.6	4 11.8	
8	0 21 45.3	2 42.5		23	0 13 45.6	4 16.4	
9	0 21 5.9	2 50.3	0.0666	24	0 13 24.2	4 20.8	0.0976
10	0 20 27.3	2 57.8		25	0 13 4.4	4 25.0	
11	0 19 49.4	3 5.2		26	0 12 46.0	4 28.8	
12	0 19 12.6	3 12.4	0.0715	27	0 12 29.4	4 32.4	0.1056
13	0 18 36.8	3 19.4		28	0 12 14.4	4 35.7	
14	0 18 1.9	3 26.1		29	0 12 0.9	4 33.8	
15	0 17 28.3	—3 32.7	0.0771	30	0 11 49.2	—4 41.6	0.1139

The *sixty-first* asteroid was discovered by the indefatigable Mr. GOLDSCHMIDT. It was first seen by him on the evening of September 9, but illness prevented him from finding it again before the 19th, and unfortunately precluded him from following up the discovery by a series of observations. The planet was, however, found by Dr. LUTHER, in Bilk, at the instance of Mr. GOLDSCHMIDT, and, at his suggestion, has received the name of *Danaë*.

On the 9th September *Danaë* was on the same parallel with

the star Lal. 44384, and about five seconds farther east. Other observations (from the *Astr. Nachrichten*) are:—

Date.	Place.	M. T. of Place	α	δ
Sept. 19	Paris,	^h 8 ^m 2 ^s	^h 22 ^m 25 ^s 43.8	[°] —3 ['] 48 ^{''} 43.0
22	Bilk,	11 32	22 23 10	—3 40
27	Berlin,	11 47 38	22 19 30.2	—3 26 14.9
Oct. 3	Vienna,	9 25 5.3	22 16 1.7	—3 9 28.6

The observers agree in estimating the magnitude as about $10\frac{1}{2}$.

The *sixty-second* asteroid was discovered at Berlin in the course of the search for the *fifty-ninth*, for which it was taken by Drs. FÖRSTER and LESSER, until the large discordances

from the positions as observed at Bilk, Vienna, and Greenwich made it impossible to doubt that the object observed at Berlin was still another small planet. Its magnitude was 11.

The observations at Berlin were as follows:—

Date.	Berlin M. T.	(62) α	(62) δ
1860, Sept. 14	^h 13 ^m 17 ^s 5	^h 0 ^m 38 ^s 4.42	[°] +0 ['] 56 ^{''} 3.0
19	11 16 19	34 51.28	0 30 34.3
20	10 20 48	34 10.81	0 25 33.2
23	10 17 32	32 4.41	0 9 50.0
24	12 38 11	31 17.06	+0 4 4.6
Oct. 6	13 19 20	22 30.34	—0 57 55.3
8	11 40 15	21 8.08	1 7 6.1
10	11 9 47	0 19 45.67	—1 16 26.4

Prof. PETERS gives elements and an ephemeris of this planet, computed by Dr. SCHJELLERUP, for 1860, September 14, Berlin M. T., and the mean equinox of 1860.0.

$$\begin{aligned} M &= 339^{\circ} 48' 37'' \\ L &= 11 \ 2 \ 30.3 \\ \Omega &= 126 \ 54 \ 31.8 \\ \pi &= 31 \ 13 \ 53.3 \\ i &= 2 \ 12 \ 42.8 \\ \varphi &= 9 \ 49 \ 18.4 \\ \mu &= 6.44''.937 \\ a &= 0.493660 \end{aligned}$$

EPHEMERIS FOR BERLIN MEAN NOON.

Date.	(62) α h m	(62) δ h m	Log Δ	Date.	(62) α h m	(62) δ h m	Log Δ
1860 Oct. 22	0 12.7	—2 1.1	0.2255	1860 Nov. 6	0 7.3	—2 27.5	
23	12.2	3.9		7	7.1	28.0	0.2547
24	11.7	6.7		8	6.9	28.0	
25	11.1	9.3		9	6.7	28.0	
26	10.6	11.9	0.2317	10	6.4	28.0	
27	10.2	14.0		11	6.1	28.0	0.2635
28	9.9	16.0		12	6.3	27.7	
29	9.5	18.0		13	6.4	27.1	
30	9.2	19.7	0.2387	14	6.6	26.3	
31	8.9	21.6		15	6.7	25.4	0.2727
Nov. 1	8.6	23.2		16	6.7	24.3	
2	8.3	24.7		17	6.8	23.1	
3	8.0	25.8	0.2464	18	6.9	22.0	
4	7.8	26.5		19	0 7.0	—2 20.6	0.2823
5	0 7.5	—2 27.0					

NEW COMET.

Mr. LEVERRIER publishes a telegraphic despatch received by him from Mr. TEMPEL at Marseilles, announcing the detection by him of a small comet, October 23.

At 16 $\frac{1}{2}$ ^h of that day the comet preceded the star Lal. 19832 by 6', and was 28' 50'' farther south.

October 24, 15^h 6^m, the comet preceded 23 *Leonis Minoris* by 3^m 13.5, being 7^m 15^s farther south.

Mr. YVON VILLARCEAU observed the comet at Paris.

Paris M. T.	α h m s	δ ° ' "
1860 Oct. 25,	15.5	10 5 3 31 26

The hourly motion in α was insensible; in δ it was —5'.1.

EPHEMERIS OF MELPOMENE FOR THE OPPOSITION IN 1861.

By ERNEST SCHUBERT.

[Communicated by Captain C. H. DAVIS, U. S. N., Superintendent Nautical Almanac.]

Washington Mean Midnight.	α h m s	δ ° ' "	Log Δ	Log r	Washington Mean Midnight.	α h m s	δ ° ' "	Log Δ	Log r
1861 Jan. 0	9 22 31.73	+ 8 16 36.3	0.183230	0.372393	1861 Jan. 19	9 7 58.27	+10 17 50.9	0.159480	
1	21 59.56	21 13.4	179533		20	7 0.40	25 51.8	159065	0.380940
2	21 25.57	26 3.4	177886	373270	21	6 1.80	33 59.8	158733	
3	20 49.85	31 6.3	176290		22	5 2.52	42 14.1	158485	381767
4	20 12.40	36 22.0	174748	374143	23	4 2.70	50 34.4	158321	
5	19 33.47	41 50.1	173261		24	3 2.38	10 59 0.1	158243	382591
6	18 52.51	47 30.6	171833	375008	25	2 1.61	11 7 30.9	158248	
7	18 10.21	53 23.2	170463		26	9 1 0.51	16 6.0	158339	383109
8	17 26.36	8 59 27.6	169158	375869	27	8 59 59.12	24 45.0	158516	
9	16 41.03	9 5 43.5	167908		28	58 57.54	33 27.7	158781	384222
10	15 54.27	12 10.9	166747	376727	29	57 55.81	42 13.6	159131	
11	15 6.13	18 49.2	165642		30	56 54.05	51 2.0	159569	385031
12	14 16.67	25 38.3	164610	377579	31	55 52.31	11 59 52.3	160093	
13	13 25.94	32 37.8	163649		Feb. 1	54 50.75	12 8 41.1	160704	385834
14	12 33.98	39 47.0	162761	378427	2	53 49.35	17 36.9	161400	
15	11 40.88	47 6.1	161948		3	52 48.24	26 30.0	162183	386633
16	10 46.69	9 54 34.5	161213	379268	4	51 47.51	35 23.1	163050	
17	9 51.48	10 2 11.7	160555		5	50 47.18	44 15.5	164003	0.387427
18	9 8 55.31	+10 9 57.4	0.159977	0.380106	6	8 49 47 38	+12 53 6.6	0.165037	

Washington Mean Midnight.	α	δ	Log Δ	Log r	Washington Mean Midnight.	α	δ	Log Δ	Log r
	^h ^m ^s	[°] ['] ^{''}				^h ^m ^s	[°] ['] ^{''}		
1861 Feb. 7	8 48 48.20	+13 1' 56.0	0.166156	0.388213	1861 Feb. 21	8 36 43.60	+14 58' 29.8	0.189735	0.393586
8	47 49.71	10 43.5	167355		22	36 1.61	15 6 4.6	191914	
9	46 51.97	19 28.2	168637	388996	23	35 21.18	13 32.0	194150	394333
10	45 55.12	28 9.9	169998		24	34 42.34	20 51.9	196140	
11	44 59.19	36 48.3	171437	389774	25	34 5.11	28 3.9	198783	395075
12	44 4.21	45 22.4	172952		26	33 29.48	35 7.9	201173	
13	43 10.29	13 53 52.3	174542	390547	27	32 55.52	42 3.9	203611	395812
14	42 17.47	14 2 17.3	176204		28	32 23.24	48 51.5	206096	
15	41 25.82	10 37.1	177940	391315	Mar. 1	31 52.65	15 55 30.8	208625	396542
16	40 35.42	18 51.4	179743		2	31 23.83	16 2 1.9	211195	
17	39 46.30	26 59.9	181615	392078	3	30 56.74	9 24.4	213807	397267
18	38 58.49	35 2.2	183550		4	30 31.39	15 38.2	216456	
19	38 12.07	42 58.2	185550	0.392835	5	8 30 7.82	+16 21 43.3	0.219142	0.397989
20	8 37 27.09	+14 50 47.5	0.187612						

8 1861, January 31, 22^h 41^m.8 Washington M. T. Intensity of light = 0.72.

OSCULATING ELEMENTS.

1861, February 4.0, Washington M. T.

$$\begin{aligned}
 M &= 94^{\circ} 23' 33.4 \\
 \pi &= 15 20 22.1 \\
 Q &= 150 5 18.6 \\
 i &= 10 9 3.0 \\
 \varphi &= 12 32 17.2 \\
 \mu &= 1019''.4198 \\
 \log a &= 0.361102
 \end{aligned}
 \quad \left. \begin{array}{l} \\ \\ \\ \\ \\ \\ \end{array} \right\} \text{M. Eq. Ep.}$$

I would give notice here that I have computed the general perturbations of *Melpomene* by *Jupiter*, using Prof. ENCKE's method, published in the *Berliner Jahrbuch* for 1857. They will be published, together with the tables I have constructed upon them, by the American Nautical Almanac, and are already printing.

NEW WORK.

Translation of the Sârya-Siddhânta, a Text-Book of Hindu Astronomy; with Notes, and an Appendix containing additional Notes and Tables, Calculations of Eclipses, a Stellar Map, and Indexes. By Rev. EBENEZER BURGESS, assisted by the Committee of Publication of the American Oriental Society. From the Journal of the Am. Oriental Society, Vol. VI. New Haven. 1860. pp. 354.

THE character of this highly interesting and valuable work may be gathered from a few passages compiled from the Introduction:—

A comprehensive exhibition of the Hindu system had nowhere been made. The *Astronomie Indienne* of BAILLY, the first extended work upon its subject, had long been acknowledged to be founded upon insufficient data, to contain a greatly exaggerated estimate of the antiquity and value of the Hindu astronomy, and to have been written for the purpose of supporting an untenable theory. The articles in the *Asiatic Researches*, by DAVIS, COLEBROOKE, and BENTLEY, which were the first, as they still remain the most important, sources of knowledge respecting the matters with which they deal, relate only to particular points in the system, of especial prominence and interest. BENTLEY's volume on Hindu Astronomy is mainly occupied with an endeavor to ascertain the age of the prin-

cipal astronomical treatises, and the epochs of astronomical discovery and progress, and is, moreover, even in these respects, an exceedingly unsafe guide. The treatment of the subject by DELAMBRE, in his History of Ancient Astronomy, being founded only upon BAILLY and the earliest of the essays in the *Asiatic Researches*, partakes, of course, of the incompleteness of his authorities.

In short, there was nothing in existence which showed the world how much and how little the Hindus know of astronomy, nor yet their mode of presenting the subject in its totality, the intermixture in their science of old ideas with new, of astronomy with astrology, of observation and mathematical deduction with arbitrary theory, mythology, cosmogony, and pure imagination. It seemed to Mr. BURGESS that nothing would so well supply the deficiency as the translation and detailed explication of a complete treatise of Hindu Astronomy; and this work he accordingly undertook to execute.

Among the different *Siddhântas*,* or text-books of astronomy, existing in India in the Sanskrit language, none appeared better suited for the purpose than the *Sûrya-Siddhânta*. That

* This word, which nsage has made to signify an "astronomical text-book," has etymologically and historically no such meaning, but denotes simply an "established conclusion."

it is one of the most highly esteemed, best known, and most frequently employed of all, is quite evident to all who have noticed how much oftener than any other it is referred to as authority in the various papers on the Hindu Astronomy.

The first rough draft of the translation and notes was made while Mr. BURGESS was still in India, with the aid of Brahmins who were familiar with the Sanskrit and well versed in Hindu astronomical science. In a few points also he received help from the native Professor of Mathematics in the Sanskrit College at Pûna. But notwithstanding this, there remained not a few obscure and difficult points, connected with the demonstration and application of the processes taught in the text. In the solution of these, the translator expresses his acknowledgments for very important assistance rendered him by the Committee* of Publication of the Society, who have also — the main share of the work falling to Professor WHITNEY — enriched the notes with much additional matter of value, the whole collected material, in fact, having been placed in their hands for revision, expansion, and reduction to the form best answering to the requirements of modern scholars. Mr. BURGESS also expresses his indebtedness to Professor NEWTON of Yale College for valuable aid, as well as for constant advice and suggestions, adding much to the value of the work.

The *Sûrya Siddhânta*, like the larger portion of the Sanskrit literature, is written in the verse commonly called the *çloka*, or in stanzas of two lines, — each line being composed of two halves, or *pâdas*, of eight syllables each. . . . The style of expression of the treatise is, in general, excessively concise and elliptical, often to a degree that would make its meaning entirely unintelligible without a commentary and the exposition of a native teacher, or such a knowledge of the subject treated of as should show what the text must be meant to say. . . . In both the translation and the notes, the interests of two classes of readers have been kept steadily in view, those who are orientalists without being astronomers, and those who are astronomers without being orientalists.

The notes are of much historical interest and value in their astronomical bearings, as well as in their philological relations. Among other interesting contents are to be found full calculations of the lunar eclipse of 1860, February 6, and the solar eclipse of 1854, May 26, according to the data and methods of the *Sûrya Siddhânta*, and a comparison of the results with those deduced from our astronomical Almanacs. A map is

* MESSRS. SALISBURY, WHITNEY, and HADLEY of Yale College, ABBOT of Cambridge, and TURNER of Washington.

given, showing the heavens in plane projection from 70° N. to 50° S. of the ecliptic, with the equators of B. C. 2350 and A. D. 560, — and in connection with a table given for the purpose, illustrating the relations between the astrognostic systems of the Arabs, the Hindus, and the Chinese. The positions of the Junction-stars of the asterisms have been carefully computed and presented in a tabular form, and the whole of this important subject, the asterisms, submitted to a thorough philological and scientific discussion. Deducing the true longitudes and latitudes of the Junction-stars of the asterisms as from the positions given in the Sanskrit text, and comparing these with the actual longitudes (A. D. 560) and latitudes of the stars with which they are probably to be identified, the average error in longitude (omitting proper-motions) is $-0^{\circ} 56'$, the greatest errors being $+2^{\circ} 31'$ and $-3^{\circ} 1'$. This would indicate an employment of the vernal equinox of about 490 A. D. Such a determination of date is but rough, yet it is the best attainable. The errors of latitude are great and irregular, varying from $+70^{\circ}$ for α Orionis, to -3 for δ Leonis. The largest errors are in the measurement of southern latitudes, and are all in the same direction, putting the star too far north.

The historical conclusions reached by the authors are summed up thus: —

“We would suggest, then, as the theory best supported by all the evidence thus far elicited, that a knowledge of the Chinese Astronomy, and with it the Chinese division of the heavens into twenty-eight mansions, was carried into Western Asia at a period not much later than B. C. 1100, and was there adopted by some western people, either Semitic or Iranian. That in their hands it received a new form, such as adapted it to a wider and less scientific method of observation, the limiting stars of the mansions being converted into zodiacal groups or constellations, and in some instances altered in position so as to be brought nearer to the general planetary path of the ecliptic. That in this changed form, having become a means of roughly determining and describing the places and movements of the planets, it passed into the keeping of the Hindus, — very probably along with the first knowledge of the planets themselves, — and entered upon an independent career of history in India. That it still maintained itself in its old seat, leaving its traces later in the *Bundehesh*; and that it made its way so far westward, as finally to become known to, and adopted by, the Arabs. The farther modifications introduced into it by the latter people all have in view a single purpose, that of establishing its stations in the immediate neighborhood of the ecliptic.”

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CYCLIC SOLUTIONS OF THE SCHOOL-GIRL PUZZLE.

By BENJAMIN PEIRCE, LL. D.,

PERRINS PROFESSOR OF ASTRONOMY AND MATHEMATICS IN HARVARD UNIVERSITY.

The Puzzle.

1. A GIVEN number, f , of girls are required to walk for a given number, h , of days in a given number, g , of ranks, of which each rank consists of a given number, k , of girls; subject to the condition that each girl is to walk once, and only once, in the same rank with every other girl.

Algebraic conditions.

2. Since the whole number, f , of girls, must walk each day in g ranks, of which each consists of k girls, it is apparent that

$$f = gk.$$

3. Each girl walks with $k - 1$ different companions each one of the h days, and thereby walks with each of her $f - 1$ companions. The algebraic expression of this condition is

$$f - 1 = h(k - 1).$$

4. The combination of these two equations gives

$$g = h - \frac{h-1}{k},$$

so that $h - 1$ must be divisible by k . If the quotient is denoted by p , the equations of condition are

$$h = kp + 1$$

$$g = h - p$$

$$f = gk$$

in which k and p are arbitrary integers.

The condition of cyclic permutation.

5. This puzzle may be solved by trial in many different ways; but the only forms of solution which are of scientific interest are those which are founded upon law. The law, to which the present solutions are subject, is that *the change of relative position, by which the girls pass in their ranks from the first day to the second, is the same in every subsequent day; and if the same system of interchanging position were continued one day longer, the position of the first day, or some transformed equivalent of this position, would be reproduced.*

6. The term *transformed equivalent* needs to be defined.

It is here used to denote a changed position, in which the companions of a rank are placed in a different order, without any change from one rank to another.

7. The operation, by which any position of the girls is changed to any other position, may be denoted by the letter x ; or x may be regarded as the ratio of the second position to the first. The application of the operation x to the second position gives a third position, which bears to the first the relation of x^2 ; the same is true of every new application of this operation, and the m th application of the operation gives a position which bears to the original one the relation of x^m . But the number of positions of a finite system of elements must be finite; so that, sooner or later, in the successive application of the operations, a position must be repeated. When it is considered that the reversal of the system of change, by which the successive positions were obtained, must reproduce the original positions in the reversed order, it is apparent that the first of the repeated positions is the original position of the series. If, then, m denotes the number of operations which reproduces the original position, it satisfies the equation

$$x^m = 1,$$

which gives

$$x = \sqrt[m]{1};$$

and consequently *the relation of one position to any other may be expressed as a root of unity.*

8. The root of unity which expresses a given change of position is readily ascertained. It is only necessary to find the various cycles of elements, which are connected together by each taking the place of another. Observe, for instance, what place the first girl moved into, and then the position into which the girl thus displaced is removed, and so on continuously, until we come to the girl who is moved into the first place. These girls constitute a cycle. Find a second cycle, in the same way, among the girls not included in the first, and then a third, and a fourth, until all the girls are distributed into cycles. Denote the numbers of girls in the successive cycles by $q, q', \&c.$; and if m is the least common multiple of these

numbers, it is also the root of unity which expresses the proposed change of position.

9. In the change to a transformed equivalent, the sum of the cyclic numbers $q, q', \&c.$, for each rank, is equal to the number, k , of girls in the rank. If, then, q_k denotes the least common multiple of all the numbers from unity to k inclusive, the value of m , in the case of a transformed equivalent, is one of the divisors of q_k .

10. The consideration of the daily change in the positions of the girls is not diminished in generality by selecting some one girl at will, and assuming her to be fixed in position, while all her companions successively come into the same rank with her. Since each girl returns to the rank of the one who is fixed, in just h days, the number of girls in each cycle of a solution of the present puzzle must either be h or some multiple of h . When the position, to which the girls return after the full series of h days, is a repetition of the first position, each cycle consists of h girls; but when the recurring position is a transformed equivalent of the original one, the number of girls in one or more of these cycles must be a multiple of h .

11. In all the examples, the girl who is stationary will be denoted by the letter a ; and all the girls of each cycle will be denoted by a common letter. The girls of a cycle will be distinguished from each other by the subjacent indices of the common letter, which will extend from zero to $h'-1$, if h' is the number of girls in the cycle. It is sufficient to write the arrangement of the first day of the series, in which the indices are to be so disposed that each subsequent day can be obtained by increasing all the indices by unity; and indices which are congruous with reference to h' as a modulus must be regarded as identical.

12. If, in a given solution, all the indices are subtracted from h' , it is plain that the result is a solution of the problem, which may be called *the negative of the given solution*.

13. If, in a given solution, all the indices are multiplied by any number which is prime to $h, h', \&c.$, it is easy to prove that the result is a solution of the problem, but it is one which should properly be regarded as equivalent to the given solution, from which it is derived. For it is easy to see that this multiplication of the indices is identical with adopting a law of transition, which, instead of expressing the relation of the first day to the second, expresses that of the first day to some subsequent day. Thus, if α is the number which multiplies the indices, and if β is determined by the condition that for each cycle

$$\alpha \beta \equiv 1 \pmod{h'},$$

which is always capable of solution, $\beta+1$ is the number of the day into which the first day is changed by the new law of transition; since β is prime to h , the application of the new law must give all the days of the original solution, although the order of succession is changed.

14. The test of the correctness of a solution, when each cycle is composed of h girls, is, that, in taking the differences of the

subjacent indices of the same letter in each rank, all possible differences are obtained without any repetition; and the same must be the result of taking all the differences of the indices of each pair of different letters in the same rank. In taking these differences, the larger number must be subtracted from the smaller, as well as the reverse, and differences, which are congruous with reference to h , must be considered as identical. When the number of girls in a cycle is h' , the same difference must be repeated as often as h is contained in h' ; but in this case it will be observed that, by the conditions of the solution, any day is changed into its transformed equivalent by increasing all the subjacent numbers by h .

SPECIAL CASES.

Cases in which $k = 2$.

15. In these cases, the equations of § 4 become

$$\begin{aligned} h &= 2p+1, \\ g &= p+1, \\ f &= h+1, \end{aligned}$$

and the law of transition is of the algebraic type $\sqrt[h]{1}$.

16. It is not possible, from any solution of this case, to obtain a new solution by the mere interchange of the four indices of two different ranks.

For if s' and s are the indices of one rank, and t' and t those of another, of all which s is the least index, and $t > t'$, it is impossible to replace the two differences $s'-s$ and $t'-t$ by any other combination of them. For if this were possible, either

$$\begin{aligned} s'-s &\equiv \pm(s'-t) & \text{or} & \pm(s'-t') \pmod{h}, \\ t'-t &\equiv \pm(s-t') & \text{or} & \pm(s-t) \pmod{h}, \end{aligned}$$

which give

$$s = t \text{ or } t', \text{ or } 2s' \equiv 2t' \text{ or } 2t \pmod{h},$$

which are impossible; or else

$$\begin{aligned} s'-s &\equiv \pm(s-t) & \text{or} & \pm(s-t') \pmod{h}, \\ t'-t &\equiv \pm(s'-t') & \text{or} & \pm(s'-t) \pmod{h}, \end{aligned}$$

which give

$$s' \equiv t \text{ or } t', \text{ or } 2s \equiv 2t \text{ or } 2t' \pmod{h},$$

which are impossible. The impossibility of the doubled congruences depends upon the fact that h is odd.

17. Whenever several ranks can be found admitting of such an arrangement that the second index of each of the ranks added to the first index of the subsequent rank is congruous for the modulus h with the sum of the first index of the first rank of the set added to the second index of the last rank, a new solution can be obtained by moving down all the second indices of the set till each index is two ranks lower than in its original position, regarding the lower rank as the one next above the highest. For if the ranks of the set are numbered $0, 1, 2, \&c.$, and if the first index of the rank numbered r is f_r , and the second index s_r , the given condition is expressed by the congruence

$$s_{r-1} + f_r \equiv s_r + f_{r+1} \pmod{h},$$

which gives

$$f_r - s_r \equiv f_{r+1} - s_{r+1} \pmod{h},$$

with the proper modifications for the last and bottom of the set, which agrees with the statement of the proposition.

18. Whenever several ranks can be found such that, after moving the second indices down by n ranks, the condition of the previous proposition is obtained, a new solution can be derived by moving them $n+2$ ranks still lower. The demonstration of this theorem is an easy modification of the preceding.

19. If b is adopted as the letter of the cycle in these cases, a general solution is one for which $a b_0$ is the first rank of the first day, and the two indices of any subsequent rank x are x and $h-x$. This solution is plainly its own negative.

20. When h is a prime number of the form $4m+3$, if γ is one of its primitive radicals, $\frac{1}{2}(h-1)$ solutions are contained in the form for which $a b_0$ is the first rank of the first day, and the two indices of any subsequent rank x are γ^{2x-1} and γ^{2x+2n} , in which n is any integer from 0 to $\frac{1}{2}(h-3)$ inclusive. The solution which corresponds to

$$n = \frac{1}{2}(h-3)$$

is that of the preceding section, and one half of the remaining solutions are the negatives of the other half. The process of § 13, applied to either of these solutions, can only give its own negatives as its equivalent. Modifications of the solution can be given for cases in which h is not a prime number of the form $4m+3$.

Case in which $h=3$.

21. In this case it is readily inferred from the equations of § 4 that

$$\begin{aligned} k &= 2, & p &= 1, \\ g &= 2, & f &= 4, \end{aligned}$$

and the solution of § 19 is

$$\begin{aligned} a & b_0, \\ b_1 & b_2, \end{aligned}$$

which is evidently the only solution.

Case in which $h=4$.

22. In this case, the equations of § 4 give

$$\begin{aligned} k &= 3, & p &= 1, \\ g &= 3, & f &= 9. \end{aligned}$$

The eight girls which remain after taking out the stationary girl cannot be divided into two cycles of four girls each. For this would involve the necessity of placing the three girls of each cycle which were not in the first rank into a rank by themselves, in which disposition there could not be the requisite combination of the girls of one cycle with those of the other; or else two of them must be placed in one rank, with one in the other, in which case there would be five different combinations of each girl of either cycle with the girls of the other cycle, while there are only four girls to satisfy these combinations.

By combining all the eight girls into one cycle, we instantly obtain the solution

$$\begin{aligned} a & b_0 b_4 \\ b_1 & b_2 b_{-1} \\ b_{-3} & b_{-2} b_3, \end{aligned}$$

which satisfies the test of § 14. The negative of this solution is

$$\begin{aligned} a & b_0 b_{-4} \\ b_{-1} & b_{-2} b_1 \\ b_3 & b_2 b_{-3}. \end{aligned}$$

There is no other solution, for the only other combinations of the index *one* with two other indices, which are consistent with the last condition of § 14, are combinations with 2 and 3, or with 3 and -2 ; but these combinations are inconsistent with the other condition of § 14, because

$$3-2=2-1, \quad \text{and} \quad -2-1 \equiv 3+2 \pmod{8}.$$

Cases in which $h=5$.

23. In these cases

$$kp=4,$$

so that either $k=2, \quad p=2;$

or $k=4, \quad p=1.$

24. The case of

$$k=2, \quad p=2,$$

gives $g=3, \quad f=6;$

of which the solution

$$\begin{aligned} a & b_0 \\ b_1 & b_{-1} \\ b_2 & b_{-2}, \end{aligned}$$

given by § 19, is by § 16 the only solution.

25. The case of $k=4, \quad p=1,$

gives $g=4, \quad f=16.$

26. If the girls which are not stationary are divided into three cycles, it is easy to see that each cycle in itself must conform to the solution of the previous section, so that it remains to fit the three cycles together, which can only be done in the following form:—

$$\begin{aligned} a & b_0 c_0 d_0 \\ b_1 & b_{-1} d_2 d_{-2} \\ b_2 & b_{-2} c_1 c_{-1} \\ d_1 & d_{-1} c_2 c_{-2}. \end{aligned}$$

27. If all the girls form one cycle, the difference of unity in the indices requires the combination either of indices 1 and 2, or 2 and 3, or 3 and 4, in the same rank.

But if indices 1 and 2 are combined, the difference of 2 in the indices requires the placing of 4 in the same rank, or in the rank with the index 6. But the placing of index 4 with 6 involves the combination of the indices -1 and -7 in the same rank with 1 and 2, so that the difference, 4, is lost, and the test of § 14 cannot be satisfied. Whereas the placing of the index 4 in the same rank with 1 and 2 makes it necessary

to place —7 also in that rank, and the solution is obtained which is expressed in the form of the first day.

$$\begin{array}{cccc} a & b_0 & b_5 & b_{10}, \\ b_1 & b_2 & b_4 & b_{-7}, \\ b_6 & b_7 & b_{-6} & b_{-2}, \\ b_{-4} & b_{-3} & b_{-1} & b_3. \end{array}$$

The combination of 2 with 3 exceeds that of 1 and 4 from being in the same rank, so that in order to acquire the difference, 2, 4 must be combined with 6, or, which is the same thing, 1 with —1; but this involves the combination of —4 and —6 in the same rank with 2 and 3, which would exclude the differences 3 and 4, and therefore fails to satisfy the test.

The union of the indices 3 and 4 in the same rank is equivalent to that of —2 and —1, or the negatives of the union of 1 and 2; so that the consideration of this case can only lead to the negative of the solution already given, and no other solutions are possible.

Case in which $h = 6$.

28. In this case, the equations of § 4 give

$$\begin{array}{ll} k = 5, & p = 1, \\ g = 5, & f = 25, \end{array}$$

A cycle of six girls cannot be formed here, because three girls of such a cycle cannot be placed in the same rank, since this would require six incongruous differences of indices, whereas there are only five such differences in this cycle; and if not more than two girls of the cycle were placed in the same rank, not more than four of the five differences could be used, so that the test would not be satisfied. Neither can the girls be combined into two cycles of twelve girls each; for if four girls of either cycle were placed in the same rank, the final condition of the test would require four more should be united in another rank, which, with the two girls of the first rank, would involve thirteen incongruous differences, whereas there are only eleven such differences. The only other possible arrangement is that three girls of each cycle should be united in each of three ranks, and two girls of the same cycle in each of the other three ranks, which would only use nine of the eleven differences.

All the girls must therefore be found in one cycle. The solutions of this form are

$$\begin{array}{cccc} a & b_0 & b_6 & b_{12} & b_{-6}, & \text{and} & a & b_0 & b_6 & b_{12} & b_{-6}, \\ b_1 & b_2 & b_{-9} & b_{-2} & b_{-7}, & & b_{-11} & b_2 & b_3 & b_{-2} & b_3, \\ b_7 & b_8 & b_{-3} & b_1 & b_{-1}, & & b_{-5} & b_3 & b_3 & b_4 & b_{11}, \\ b_{-11} & b_{-10} & b_3 & b_{10} & b_3, & & b_1 & b_{-10} & b_{-9} & b_{10} & b_{-7}, \\ b_{-5} & b_{-4} & b_9 & b_{-8} & b_{11}, & & b_7 & b_{-4} & b_{-3} & b_{-8} & b_{-1}, \end{array}$$

and their negatives.

Cases in which $h = 7$.

29. In these cases, we have

$$kp = 6,$$

so that

$$k = 2, \quad p = 3,$$

or

$$k = 3, \quad p = 2,$$

or

$$k = 6, \quad p = 1.$$

30. In the case of $k = 2, p = 3$, the equations of § 4 give

$$g = 4, \quad f = 8.$$

If the prime radical of § 20, in this case, is 2, the independent solutions given by that section are

$$\begin{array}{ll} a & b_0, & \text{and} & a & b_0, \\ b_1 & b_3, & & b_1 & b_{-1}, \\ b_2 & b_{-1}, & & b_2 & b_{-2}, \\ b_{-3} & b_{-2}, & & b_{-3} & b_3, \end{array}$$

of which the first solution has a negative, which is also its equivalent. There can be no other solution, for in the three solutions here given, each of the indices 1, 2, and —3 is combined in the same rank with each of the indices —1, —2, and 3; but it cannot be possible to have a solution in which one of the indices of the first of these two sets is not combined with an index of the second set; and by § 16 it is impossible to have more than one such solution.

31. The case of $k = 3, p = 2$, gives $g = 5, f = 15$, which is the well-known original case of this puzzle.

If the girls, with the omission of the stationary girl, are divided into two cycles of seven girls in each, it is easy to see that one of the cycles must be arranged so as to have two girls united in each of three ranks, and for this cycle it is evident that one of the arrangements of the preceding case must be adopted, while the other cycle must be arranged so as to fill up the remaining places; that is, there must be three girls united in one rank, and the other girls must fill the vacant spaces in the other ranks. The only admissible combinations of indices for the three girls of the second cycle, who are united in the same rank, are 1, 2, and —3; or 1, 2, and —1; or 2, 3, and —2; or 1, 3, and —3, or their negatives. The combination of the arrangements of the two cycles gives, for independent solutions,

$$\begin{array}{lll} a & b_0 & c_0, & a & b_0 & c_0, & \text{and} & a & b_0 & c_0, \\ b_1 & b_3 & c_2, & b_1 & b_3 & c_{-3}, & & b_1 & b_{-1} & c_{-2} \\ b_2 & b_{-1} & c_{-3}, & b_2 & b_{-1} & c_1, & & b_2 & b_{-2} & c_3, \\ b_{-3} & b_{-2} & c_1, & b_{-3} & b_{-2} & c_3, & & b_3 & b_{-3} & c_{-1}, \\ c_3 & c_{-2} & c_{-1}, & c_3 & c_{-2} & c_{-1}, & & c_1 & c_2 & c_{-3}. \end{array}$$

It is impossible to have any solution in which the fourteen girls form one continuous cycle. For if all the indices of a rank are even, or if all are odd, the differences will all be even; but if two of the indices of a rank are even while the third is odd, or the reverse, four of the differences will be odd while two are even. By the final condition of the test, then, the differences of the indices in one rank will be exactly followed by those of another rank in the feature of being even or odd, so that it is easy to see that there can be no arrangement of the indices in which half of them are even while the other half is odd, which is necessary in order to satisfy the test.

32. The case of $k=6$, $h=1$, gives $g=6$, $f=36$. The girls cannot be subdivided into five cycles of seven girls each, for if the girls of one of these cycles were arranged so as to have three girls in the same rank, neither of the cycles which have the same form of arrangement could be combined with it so as to satisfy the test; and if the girls of either of the cycles were arranged so as to have three sets of two girls each placed in the same rank, this cycle could not be combined with another which was similarly disposed; and since these are the only two modes of arrangement which could be adopted with the girls of a cycle, it is necessary to reject this mode of subdivision.

If all the girls, except the stationary one, are united into one continuous cycle, the final condition of the test makes it necessary that all the ranks except the upper one can be deduced from each other, by increasing the indices by 7; so that the six indices of each rank must be of the different forms $1+7n$, $2+7n$, $3+7n$, $4+7n$, $5+7n$, and $6+7n$. In order that the difference of unity may occur in two indices of the same rank, either the index 2 must be combined with one of the indices 1 or 3, or the index 5 must be combined with one of the indices 4 or 6, or the index 3 must be combined with the index 4. These cases may be submitted to separate analysis.

If 1 and 2 are united in a rank, the other indices of the rank must have the form $3+7a$, $4+7b$, $5+7c$, $6+7d$. In order to avoid all repetition of the same indices, the following incongruences for the modulus 5 must be satisfied:—

$$\begin{aligned} a &>< 0, \\ b &>< a, \text{ or } 2a, \\ c &>< 2, 3a, b, 4-b, b+a, \text{ or } 2b-a, \\ d &>< 4-a, 2+\frac{1}{2}a, 2b, 4-b, 2+\frac{1}{2}b, c, 4-c, b+a, \\ &\quad c+a, 4+a-c, 2c-b, \text{ or } b+c-a, \end{aligned}$$

which may be called the fundamental incongruences of the case.

When $a=1$, the fundamental incongruences for b and c become

$$\begin{aligned} b &>< 1, \text{ or } 2, \\ c &>< 2, b, b+1, 2b-1, \text{ or } 4-b, \end{aligned}$$

the latter of which, when $b=3$, become

$$c >< 0, 1, 2, 3, \text{ or } 4,$$

so as to exclude this value of b ; but when $b=4$, the incongruences for c become

$$c >< 0, 2, \text{ or } 4,$$

and when $b=0$, they become

$$c >< 0, 1, 2, 4.$$

But if the values $c=1$, or $=3$, are combined with $b=4$ and $a=1$, or if the value of $c=3$ is combined with $b=0$ and $a=1$, the incongruences for d become

$$d >< 0, 1, 2, 3, \text{ or } 4,$$

so that we are driven by exclusion to the incongruence

$$a >< 1.$$

When $a=2$ the fundamental incongruences for b and c become

$$\begin{aligned} b &>< 2, \text{ or } 4, \\ c &>< 2, 4, b, b+2, 4-b, \text{ or } 2b-2, \end{aligned}$$

which exclude $b=1$, or $=3$, and, when $b=0$, exclude all values of c except $c=1$, which case is itself excluded by the fundamental incongruences for d ; whence we derive the incongruence

$$a >< 2.$$

When $a=3$, the fundamental incongruences for b and c become

$$\begin{aligned} b &>< 1, \text{ or } 3, \\ c &>< 1, 2, b, b+3, 2b-3, \text{ or } 4-b, \end{aligned}$$

which exclude $b=0$, and by combination with the fundamental incongruences for d , exclude the other values of b , and therefore give

$$a >< 3.$$

In the same way, it may be shown that

$$a >< 4,$$

which amounts to the exclusion of all values of a , when the indices 1 and 2 occur in the same rank. Such an occurrence is, therefore, inconsistent with a solution of this case.

By the same process, it may be demonstrated that the index 3 cannot be in the same rank with either of the indices 2 or 4. Whence it follows that the index 5 cannot be in the same rank with either of the indices 4 or 6, for with such a solution —2 would be in the same rank of one of the indices —3 and —1, so that in its negative the index 2 would be in the same rank with one of the indices 3 and 1, which has just been proved to be impossible. There is, therefore, no solution of this case.

Case in which $h=8$.

33. In this case, the equations of § 4 give

$$\begin{aligned} k &= 7, & p &= 1, \\ g &= 7, & f &= 49. \end{aligned}$$

The only modes of arrangement which require any examination are those of three cycles consisting of sixteen girls in each cycle, and that in which all the forty-eight girls form one continuous cycle.

In the case of the subdivision into three cycles, the ranks which do not contain the stationary girl must be in pairs, which change into each other by increasing the indices by 8. The combination which would here be needed to give the requisite number of differences of the indices, would place four girls of one of the cycles in each rank of one of the three pairs, two more girls of the same cycle in each rank of a second pair, and one girl of the same cycle in each rank of the third pair. No two indices of the same rank, whether they belong to the same or different cycles, except those of the first rank, can be congruous with reference to the modulus 8; and no index of one cycle in a rank can be congruous, with reference to the modulus 16, to the arithmetical mean between two other indices of the same rank and cycle. The only arrangements of four indices of the same cycle which are admissible into one rank are 1, 2, 11, and 13; 1, 2, 6, and 15; 3, 4, 13, and 15;

2, 3, 5, and 11, with the 8 which are their equivalents, and can be obtained by multiplication by 3 with reference to the modulus 16, and the negatives of the whole set. But the examination of combinations may be almost wholly limited to the consideration of the four arrangements, which are here written down, and a very short inquiry will lead to the conclusion that there is no mode of solving the example in the proposed forms.

With regard to the solutions in which all the forty-eight girls form one continuous cycle, the investigation may be conducted in the same method as in the case of $h = 6$, and the following solution will be obtained : —

a	b_0	b_8	b_{16}	b_{24}	b_{-16}	b_{-8}
b_1	b_2	b_{11}	b_{-12}	b_5	b_{-10}	b_{-17}
b_9	b_{10}	b_{17}	b_{-4}	b_{13}	b_{-2}	b_{-9}
b_{17}	b_{18}	b_{-21}	b_4	b_{21}	b_6	b_{-1}
b_{-23}	b_{-22}	b_{-13}	b_{12}	b_{-19}	b_{14}	b_7
b_{-15}	b_{-14}	b_{-5}	b_{20}	b_{-11}	b_{-2}	b_{15}
b_{-7}	b_{-6}	b_3	b_{-20}	b_{-3}	b_{-18}	b_{23}

Three equivalent solutions can be derived from this by multiplying the indices by 5, with reference to the modulus 48, and of these solutions there are also 4 negatives ; but there are no other solutions.

The investigation, by which the above solution is obtained, needs to be carried into full detail only in the cases in which the index 2 occurs in the same rank with one of the indices 1 and 3. The further consideration of other cases may be restricted to those which cannot be reduced to equivalent solutions of the previous cases. These cases are only those in which the indices 3, 4, and 29 occur in the same rank together with one of the two indices 23 and 33. The combination with the index 33 is excluded, because there is no index of the form $2 + 8a$, which can be united with such a combination ; and the combination with the index 23 cannot be reconciled with the union of indices of the form $2 + 8a$ and $1 + 8b$.

Cases in which $h = 9$.

34. The cases of this class are either those in which $k = 2$, 4, or 8.

35. The case of $k = 2$ gives

$$p = 4, \quad g = 5, \quad f = 10.$$

The method of § 19 applied to this case, with the modification required because h is not prime, and with the use of 2 as the radical base, gives the two solutions

a	b_0	a	b_0
b_1	b_{-1}	b_1	b_2
b_2	b_{-2}	b_4	b_{-1}
b_3	b_{-3}	b_{-2}	b_{-4}
b_4	b_{-4}	b_{-3}	b_3

The application of § 17 to the second of these solutions gives the solution

$$\begin{array}{ll} a & b_0 \\ b_1 & b_2 \\ b_{-1} & b_{-4} \\ b_{-2} & b_3 \\ b_{-3} & b_4 ; \end{array}$$

from which equivalent solutions can be obtained by multiplying the indices by 2, and there are no other solutions.

36. The case of $k = 4$ gives

$$b = 2, \quad g = 7, \quad f = 28.$$

It is necessary to consider this case under a great variety of forms of arrangement and subdivision.

37. The case of § 36, when the girls are divided into three cycles, each of which has the form of arrangement of § 35, admits of the single solution,

a	b_0	c_0	d_0
b_1	b_{-1}	d_3	d_{-3}
b_2	b_{-2}	d_1	d_{-1}
b_3	b_{-3}	c_4	c_{-4}
b_4	b_{-4}	c_1	c_{-1}
d_4	d_{-4}	c_2	c_{-2}
d_2	d_{-2}	c_3	c_{-3}

There are probably other solutions of this case, but in which the girls are differently arranged ; and there may also be solutions of the case of $h = 9$, $k = 8$.

Cases of $h = 11$, $k = 2$.

38. In this case, we have

$$p = 5, \quad g = 6, \quad f = 12 ;$$

and there are three independent solutions included in the form given by § 18, if 2 is adopted as the primitive radical. There are also two other independent solutions of the forms,

a	b_0	a	b_0
b_1	b_{-3}	b_1	b_{-3}
b_2	b_{-1}	b_2	b_4
b_3	b_5	b_3	b_{-2}
b_4	b_{-2}	b_5	b_{-5}
b_{-5}	b_{-4}	b_{-4}	b_{-1}

with their eight equivalent solutions.

39. In closing my researches upon this puzzle, which has interested me by the curious and novel analysis into which it has led me, I cannot regard it as quite useless. The cyclic recurrence of forms, in which the formal law is evident, although this law is far different from all the usual manifestations of causal connection, may have its application to similar phenomena which are familiar in the organic world.

COMPARISON OF THE LUNAR EPHEMERIS, IN THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC, WITH GREENWICH OBSERVATIONS.

By SIMON NEWCOMB.

[Communicated by Captain C. H. DAVIS, U. S. N., Superintendent Nautical Almanac.]

Nautical Almanac Office, 1860, November 27.

SIR:—The following table exhibits a comparison of the Lunar Ephemeris of the *American Ephemeris and Nautical Almanac*, with the Greenwich meridian observations, made in the year 1858. The comparisons were made in the same manner as were those for the years 1856 and 1857, which I had the honor to lay before you in October of 1859.*

1858.	$\Delta\alpha$	$\Delta(N. P. D.)$	1858.	$\Delta\alpha$	$\Delta(N. P. D.)$	1858.	$\Delta\alpha$	$\Delta(N. P. D.)$
Jan. 1	^s −0.24	["] +2.5	May 5	^s +0.25	["] −2.5	Aug. 30	^s −0.96	["] +0.2
6	+0.15	+1.2	6	+0.15	−4.3	31	−0.66	−2.3
9	−0.29	−1.7	7	0.00	−4.5	Sept. 1	−0.60	+2.8
19	−0.15	+3.2	16	−0.24	−3.6	12	+0.13	−0.9
20		+6.3	18	−0.18	−1.6	13	+0.30	+1.3
22	−0.49	+2.6	19	−0.11	−2.0	14	+0.47	+0.4
23	−0.63	+3.1	22	0.00	+0.1	15	+0.43	−3.8
24	−0.56	+2.5	23	−0.41	−2.1	16	+0.15	−5.1
25	−0.35	−0.4	25	+0.03	−1.9	18	+0.27	−4.6
26	−0.18	+0.1	27		−1.8	21	−0.26	−2.6
27	+0.08	−0.7	30	−0.12	−10.1	22	+0.01	−1.5
28	+0.02	−6.5	June 1	−0.01	−3.9	23	+0.03	−0.8
31	−0.18	−4.5	3	+0.19	−5.2	24	+0.18	+0.5
Feb. 1	−0.13	−1.7	7	−0.38	−3.6	25	+0.13	+2.1
3	−0.30	−1.2	15	−0.26	−2.7	30	−0.35	+1.0
4	+0.01	+3.3	16	−0.24	−0.8	Oct. 2	−0.04	−3.8
7	−0.05	+2.8	17	−0.29	−4.0	15	+0.14	−7.6
17	−0.32	+0.6	18	+0.05	−6.7	16	+0.14	−6.2
18	−0.54	+0.4	21	+0.20	−0.6	17	+0.37	−3.0
19	−0.55	−3.2	22	+0.25	−0.8	20	−0.10	−4.3
20	−0.50	−1.2	24	−0.31	−2.9	22	+0.07	−5.8
21	−0.39	+0.3	25	−0.17	−4.2	28	−0.28	−4.2
22	−0.54	+4.0	27	−0.09	−1.7	29	−0.23	+2.5
24	−0.25	+1.1	28	+0.24	+2.3	Nov. 11	+0.47	−0.4
25	−0.10	+2.0	30		+1.2	12	+0.24	+2.2
27	−0.22	−2.7	July 1	+0.27	+0.8	13	+0.04	+3.6
March 6	−0.27	−0.1	14		−3.8	14		−4.4
8	+0.11	+1.2	15	−0.10	−0.2	15	+0.18	−0.5
21	−0.38	+1.2	18	+0.11	−7.1	17	−0.08	−0.3
22	+0.07	−1.9	19	+0.35	−1.6	18	+0.13	−0.2
23	+0.30	−0.9	21	+0.26	−3.3	19		−4.0
24	+0.17	−0.9	25	+0.03	−7.6	20	−0.55	−1.1
25	+0.14	+2.1	26	+0.11	−5.0	21	−0.80	−1.6
26	−0.32	+0.9	28	+0.17	−2.4	22	−0.73	+0.9
27		−0.7	30	−0.33	−1.9	23	−0.46	+1.4
29	−0.10	−1.3	31	−0.27	−1.5	26	+0.10	+4.3
April 1	−0.06	+1.5	Aug. 1	−0.36	+3.3	Dec. 15		+2.6
3	−0.20	+0.7	2	−0.40	+4.3	17	+0.13	+1.2
18	−0.24		4	−0.58		18	+0.04	
19	0.00		13	+0.18		19	−0.16	
20	+0.13		19	+0.62		20		
21	+0.11		20	+0.28		21	−0.76	
22	+0.08		22	+0.04		22		
23	−0.02		23	−0.04		23	0.00	
24	−0.02		24	+0.19		24	+0.22	
25	−0.27		25	+0.16		26	+0.23	
26	−0.10		27	−0.23		27	−0.10	
28	+0.03		28	−0.40		28	−0.07	

* *Astronomical Journal*, No. 129.

The mean apparent error in right-ascension for the year, without regard to the sign, is found to be 0.237.

The distribution of the errors is shown by the following table:—

Including Limits.	No. of Errors.	Including Limits.	No. of Errors.
$\overset{s}{0.00}$ to $\overset{s}{0.09}$	29	$\overset{s}{0.50}$ to $\overset{s}{0.59}$	7
0.10 0.19	39	0.60 0.69	4
0.20 0.29	28	0.70 0.79	2
0.30 0.39	15	0.80 0.89	1
0.40 0.49	8	0.90 0.99	1

The mean error in longitude, for each month, of the solar ephemeris which has been deduced from the tables of HANSEN and OLUFSEN, is as follows:—

January, —1.1	July, —0.7
February, —1.3	August, —0.6
March, —2.1	September, —0.8
April, —1.2	October, —2.5
May, —0.5	November, —1.0
June, —0.7	December, —1.5

SIMON NEWCOMB.

SIXTY-FIRST AND SIXTY-SECOND ASTEROIDS.

MR. LUTHER has published the following Elements of the *Sixty-first* asteroid in the Meteorological Bulletin of the Paris Observatory. They are derived from the apparent path during 29 days.

DANA Æ.

Epoch = 1860, Sept. 29.0, Berlin M. T.

$L = 345^{\circ} 41' 56.1''$	
$M = 5 33 56.1$	
$\pi = 340 8 0.2$	} Mean Eq. 1860.0
$\Omega = 334 18 28.7$	
$i = 18 17 0.6$	
$q = 9 23 9.4$	
$\mu = 691''.5879$	
$\log a = 0.4734395$	

DR. FÖRSTER has sent to the *Astronomische Nachrichten* Elements computed at the Berlin Observatory, for Berlin midnight, from observations September 14, 24, and October 8, by Messrs. ROMBERG and TIETJEN, for the *Sixty-second* asteroid, to which Professor ENCKE has given the name *Erato*.

ERATO.

Epoch = 1860, Sept. 24.5168

$M = 334^{\circ} 55' 19''$	
$\pi = 40 11 4$	} Mean Eq. 1860.0
$\Omega = 126 56 45$	
$i = 2 14 55$	
$q = 9 25 25$	
$\log a = 0.497554$	
$\mu = 636''.320$	

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NO. 23.

ON LUNAR OCCULTATIONS.

By HENRY M. PARKHURST.

THE following methods are based upon that of BESSEL, as explained in the *American Ephemeris*, the notation of which will be adhered to in this article when otherwise unexplained.

T^o, H^o = fundamental time and hour-angle at Washington.
 T, H, h = fundamental time and hour-angles at the place of observation.

P, Q = coördinates of the moon's center, at the time T .

p, q = coördinates at the time $(T+t)$.

x, y = coördinates affected by parallax.

x', y' = motion in 1^h , affected by parallax.

X, Y = coördinates of the point of contact.

A, D = star's right-ascension and declination at the time T .

α, δ = moon's right-ascension and declination at the time T .

α', δ' = $60 \times$ moon's motion in one minute.

α'', δ'' = difference, in 1^h , of motion in one minute.

π' = variation of moon's parallax in one hour.

The following equations will give the fundamental quantities for the time T , which may be furnished in an ephemeris:—

$$P = \frac{\sin(\alpha - A) \cos \delta}{\sin \pi}, \quad p' = \frac{\sin \alpha' \cos \delta}{\sin \pi},$$

$$Q = \frac{\sin(\delta - D)}{\sin \pi}, \quad q' = \frac{\sin \delta'}{\sin \pi},$$

$$p'' = \frac{\alpha'' \cos \delta}{8} \left(\frac{60'}{\pi} \right), \quad q'' = \frac{\delta''}{120} \left(\frac{60'}{\pi} \right),$$

$$\varpi = -\frac{\sin \pi'}{\sin \pi}, \quad c = \varpi - \sin \delta' \sin \delta,$$

$$s = \frac{\sin \pi \tan \delta}{2 \cos^2 \frac{1}{2}(\alpha - A)}.$$

The following will give the fundamental quantities, which may be conveniently tabulated:—

$a = B \cos \varphi \sin h,$	Arg.	h , every minute.
$[b] = \log B \cos \varphi \cos h,$	"	"
$w = A \sin \varphi \cos D,$	"	$\log \sin D$, or D .
$f = [5.8629] b,$	"	h , every 10^m .
$[g] = \log [5.8629] a,$	"	"
$f' = [3.5039] a,$	"	h , every 30^m .
$[g'] = \log [3.5039] b,$	"	"

The time $(T+t)$ being selected as near as possible to the desired contact, assuming $t = 0$ for the first approximation, if no better estimate can be conveniently obtained, the quantities x, y, x', y' are computed from the following equations, in which $Z = Q - w$. Neglecting the members written within brackets, and using four decimal places, the resulting contact will usually be within a fraction of a minute of the truth.

$$\begin{aligned} x &= P + tp' - a [+t^2p'' + tpc]. \\ y &= Z + tq' + b \sin D [+t^2q'' + tq\varpi + p^2s]. \\ x' &= p' \div 3600 - f [+ \gamma^m f']. \\ y' &= q' \div 3600 - g \sin D [-\gamma^m g' \sin D]. \end{aligned}$$

Then, from the equations

$$X = x + \gamma x', \quad Y = y + \gamma y',$$

and the following table of lunar coördinates, we may readily ascertain by trial the value of γ ; and the time of contact will be $T + t + \gamma$. These coördinates are derived from

$$X = k \sin Q, \quad Y = k \cos Q.$$

The signs of X and Y , therefore, determine the quadrant in which Q is to be taken, as follows:—

Quadrant,	1st.	2d.	3d.	4th.
Signs of X ,	+	+	—	—
Signs of Y ,	—	+	+	—

In this table, Δ represents the difference in Y corresponding to a change of 100 in X , and is given to aid in interpolating.

LUNAR COÖRDINATES.

Q	X	Y	Δ	Q	X	Y	Δ	Q	X	Y	Δ			
0° 180	0.00000	0.27227	00	90° 90°	15° 165°	0.07047	0.26299	27	75° 105°	30° 150°	0.13614	0.23579	58	60° 120°
	0119	227	00			7162	268	27			3716	520	58	
	0238	226	01			7276	237	28			3819	460	59	
	0356	225	01			7391	205	28			3921	399	59	
1 179	0.00475	0.27223	02	89 91	16 164	0.07505	0.26172	29	74 106	31 149	0.14023	0.23338	60	59 121
	0594	221	02			7619	139	29			4125	277	61	
	0713	218	03			7733	106	30			4226	215	61	
	0834	214	03			7847	072	30			4327	153	62	
2 178	0.00950	0.27210	03	88 92	17 163	0.07960	0.26037	31	73 107	32 148	0.14428	0.23090	62	58 122
	1069	206	04			8074	002	31			4529	027	63	
	1188	201	04			8187	25967	32			4629	22963	64	
	1306	196	05			8301	931	32			4729	899	64	
3 177	0.01425	0.27190	05	87 93	18 162	0.08414	0.25894	32	72 108	33 147	0.14829	0.22834	65	57 123
	1544	183	06			8527	857	33			4928	770	66	
	1662	176	06			8639	820	33			5028	704	66	
	1781	169	07			8752	782	34			5127	638	67	
4 176	0.01899	0.27161	07	86 94	19 161	0.08864	0.25744	34	71 109	34 146	0.15225	0.22572	67	56 124
	2018	152	07			8976	705	35			5324	506	68	
	2136	143	08			9089	665	35			5421	439	69	
	2255	134	08			9200	625	36			5519	371	69	
5 175	0.02373	0.27123	09	85 95	20 160	0.09312	0.25585	36	70 110	35 145	0.15617	0.22303	70	55 125
	2491	113	09			9424	544	37			5714	235	71	
	2610	102	10			9535	503	37			5811	166	71	
	2728	090	10			9646	461	38			5907	097	72	
6 174	0.02846	0.27078	11	84 96	21 159	0.09757	0.25419	38	69 111	36 144	0.16004	0.22027	73	54 126
	2964	065	11			9868	376	39			6100	21957	73	
	3082	052	11			9979	332	39			6195	887	74	
	3200	038	12			10089	289	40			6291	816	75	
7 173	0.03318	0.27024	12	83 97	22 158	0.10199	0.25244	40	68 112	37 143	0.16386	0.21744	75	53 127
	3436	27009	13			0309	200	41			6480	673	76	
	3554	26994	13			0419	154	41			6575	601	77	
	3672	978	14			0529	109	42			6669	528	77	
8 172	0.03789	0.26962	14	82 98	23 157	0.10638	0.25063	42	67 113	38 142	0.16763	0.21455	78	52 128
	3907	945	14			0748	016	43			6856	382	79	
	4024	928	15			0857	24969	43			6949	308	80	
	4142	910	15			0966	921	44			7042	234	80	
9 171	0.04259	0.26892	16	81 99	24 156	0.11074	0.24873	45	66 114	39 141	0.17135	0.21159	81	51 129
	4377	873	16			1183	825	45			7227	081	82	
	4494	854	17			1291	776	46			7318	009	82	
	4611	834	17			1399	726	46			7410	20933	83	
10 170	0.04728	0.26813	18	80 100	25 155	0.11507	0.24676	47	65 115	40 140	0.17501	0.20857	84	50 130
	4845	792	18			1614	626	47			7592	781	85	
	4962	771	19			1722	575	48			7683	704	85	
	5078	749	19			1829	523	48			7773	626	86	
11 169	0.05195	0.26727	19	79 101	26 154	0.11936	0.24471	49	64 116	41 139	0.17863	0.20548	87	49 131
	5312	704	20			2012	419	49			7952	470	88	
	5428	680	20			2149	366	50			8041	392	88	
	5545	656	21			2255	313	50			8130	313	89	
12 168	0.05661	0.26632	21	78 102	27 153	0.12361	0.24259	51	63 117	42 138	0.18218	0.20231	90	48 132
	5777	607	22			2467	205	52			8307	154	91	
	5893	582	22			2572	151	52			8394	074	92	
	6009	556	23			2677	096	53			8482	19993	92	
13 167	0.06125	0.26529	23	77 103	28 152	0.12782	0.24040	53	62 118	43 137	0.18569	0.19913	93	47 133
	6210	502	21			2887	23984	54			8656	831	94	
	6356	475	24			2992	928	54			8742	750	95	
	6471	447	24			3096	871	55			8828	668	96	
14 166	0.06587	0.26418	25	76 104	29 151	0.13200	0.23813	55	61 119	44 136	0.18913	0.19585	97	46 134
	6702	389	25			3304	755	56			8999	503	97	
	6817	360	26			3407	697	57			9084	420	98	
	6932	330	26			3510	638	57			9168	336	99	
15 165	0.07017	0.26299	27	75 105	30 150	0.13614	0.23579	58	60 120	45 135	0.19252	0.19252	100	45 135
	Y	X		Q		Y	X		Q		Y	X		Q

Illustration.—The best early illustration of the practical application of this method, as a whole, will be found in the occultations of the *Pleiades* on March 16, 1861, which will be visible upon the Pacific Coast of the United States. The required quantities, independent of local position are the following:—

$T^o = 12^h 51^m 48.8^s$	$p'' = +0.00103$
$H^o = 8^h 50^m 52^s$	$q'' = -0.00200$
$[\sin \pi] = 8.20093$	$\varpi = -0.00030$
$p' = +0.54201$	$\epsilon = -0.00096$
$q' = +0.09483$	$s = +0.00349$

Star.	Mag.	P	Q	$\sin D$
<i>n</i>	7	+1.05645	+1.12057	9.5866
14	9	0.72817	0.43683	9.5978
16	9½	0.69823	0.38018	9.5987
17	8	0.69282	0.48019	9.5971
19	8	0.68060	0.39518	9.5985
22	8	0.66760	0.27280	9.6001
23	8½	0.65441	0.53228	9.59628
25	8½	0.61291	0.60700	9.5950
26	9	0.58748	0.68021	9.5938
28	7	0.42545	0.81175	9.5917
34	7½	+0.08391	+0.48828	9.5969

Now let us compute the immersion of 23 *Pleiadum*, as visible at Rincon Point, San Francisco. We shall have

$d = +3^h 1^m 17^s$	$H = 5^h 49^m 35^s$
$\varphi = +37^\circ 47' 6''$	$[A \sin \varphi] = 9.78488$
$T = 9^h 50^m 31.8^s$	$[B \cos \varphi] = 9.89834$

w is found to be 0.55990, whence $Z = -0.02762$.

For the first approximation, let us assume, for the sake of convenience, $h = 6^h$; in which case $\tau = +10^m 25^s$, $t = +10^m 23^s$. We then find $x' = +15.06$, $y' = +0.35$, in the fifth decimal place. The computation proceeds as follows:—

P, Z	+0.6544	-0.0276
tp'', tq''	+0.0937	+0.0164
$p, q - w$	+0.7481	-0.0112
$-a, b \sin D$	-0.7912	0
x, y	-0.0431	-0.0112
$\gamma = -1000^s$	-0.1506	— 35
	-0.1937	-0.0147
-500 ^s	— 752	— 19
$X, Y (Q = 274^\circ)$	-0.2689	-0.0166

Then $\gamma = -1500^s$, $t + \gamma = -14^m 37^s$. Let us repeat the computation with $t = -15^m$; whence $h = 5^h 34^m 33^s$.

P, Z	+0.6544	-0.0276
tp'', tq''	-0.1355	-0.0237
$p, q - w$	+0.5189	-0.0513
$-a, b \sin D$	-0.7863	+0.0346
x, y	-0.2674	-0.0167
$\gamma = -30^s$	— 45	— 1
$X, Y (Q = 274^\circ)$	-0.2719	-0.0168

The discrepancy arises chiefly from the omission to correct $x' y'$ for $\frac{1}{2} \gamma = -13^m$. In these two computations, we have required no quantities beyond those given in the *American Ephemeris*, where $T = \delta$, $P = 0$, $Q = Y$. Let us now compute the time still more accurately from the corrections within the brackets, using five decimal places. We will assume $t = -15^m 30^s$; whence $h = 5^h 34^m 3^s$.

$f' = -0.25$	$t^2 = 0.07$
$g' = 0$	$tp = -0.14$
$x' = +14.40$	$tq = -0.14$
$y' = +0.35$	$p^2 = 0.26$
$t' = -0.27$	

P, Z	+0.65441	-0.02762
tp', tq'	-0.14002	-0.02450
$p, q - w$	+0.51439	-0.05212
$-a, b \sin D$	-0.78623	+0.03529
Approx. x, y	-0.27184	-0.01683
$t^2 p'', t^2 q''$	+ 7	— 14
$tpc, tq\varpi$	+ 13	+ 4
$p^2 s$		+ 91
Corrected x, y	-0.27164	-0.01602
$\gamma = -1^s$	— 14	— 0
X, Y	-0.27178	-0.01602

$T = 9^h 50^m 31.8^s$
$t = -15^m 30.0^s$
$\gamma = -1.1^s$
Immersion, 9 35 0.7

Groups.—In order to transfer the origin of the coördinates to a neighboring star, we add $\Delta P, \Delta Q$ to p, q and to x, y ; then apply the corrections within the brackets, together with the following correction of y , for the variations of w and $b \sin D$.

$$\text{corr. of } y = -(A \sin \varphi \sin D + b \cos D) \sin \pi \Delta Q.$$

For example, let us compute the immersion of 16 *Pleiadum*, with five places of decimals.

$t = -0.27$	$p^2 = 0.32$
$t^2 = 0.07$	$x' = +14.40$
$tp = -0.15$	$y' = +0.38$
$tq = -0.10$	

$\Delta P,$	ΔQ	+0.04382	-0.15212
		+0.519	+0.509
		-0.27184	-0.01683
$p,$	q	+0.563	+0.357
$x,$	y	-0.22802	-0.16895
$t^2 p'',$	$t^2 q''$	+	7
$tpc,$	$tq\varpi$	+	14
	$p^2 s$	+	112
corr. of y		+	78
		-0.22781	-0.16716
$\gamma = +80^\circ$		+ 1152	+ 28
		-0.21629	-0.16688
$+8^\circ$		- 115	+ 3
$X, Y (Q = 308^\circ)$		-0.21514	-0.16685

$T + t$	=	^h 9 ^m 35 ^s 1
γ	=	88
Immersion,		9 36 29

If a recomputation should be desired, it would be best, with the time thus ascertained, to compute from the coördinates P, Q directly, as a check.

Error of the Tables.—When two or more contacts have been observed, we may readily obtain the error of the tables. By means of x', y' , we compute the tabular coördinates X, Y for observed times. The true coördinates will be $X + \zeta, Y + \eta$. The quantities ζ and η , the errors of the tables divided by π , may be found by a few successive trials with the Table of Lunar Coördinates.

For instance, let us suppose that the immersion of 23 *Pleiadum* should be observed at Rincon Point 30° earlier, and that of 16 *Pleiadum* 35° earlier, than the times for which we have computed the coördinates.

	23 <i>Pleiadum</i> .		16 <i>Pleiadum</i> .	
Predicted X, Y	-0.27177	-0.01602	-0.21514	-0.16685
$t''x', t''y'$	— 432 —	11 —	— 504 —	13
	-0.27609	-0.01613	-0.22018	-0.16698
$\zeta, \eta,$	+ 432 +	11 +	+ 432 +	11
	-0.27177	-0.01602	-0.21586	-0.16687
" "	— 8 +	100 —	— 8 —	100
	-0.27185	-0.01502	-0.21594	-0.16587
" "	0 +	3	0 +	3
True X, Y	-0.27185	-0.01499	-0.21594	-0.16584

Therefore $\zeta = +0.00424$; $\eta = +0.00114$, results from this supposition.

New Place of Observation.—To obtain an approximate time, or to serve as a check upon the computation, it will sometimes be advantageous to transfer the coördinates from one station to another, especially when not far apart.

$\Delta = \varphi - \varphi^\circ$ = excess of latitude of new station.
 $l = \varphi^\circ + \frac{1}{2} \Delta$ = mean latitude of the two stations.
 d' = excess of longitude of new station.

$L = h^\circ - \frac{1}{2} d' =$ mean hour-angle.

$X', Y' =$ variation of coördinates for the new station.

$X' = (B \sin l - 0.0025) 2 \sin \frac{1}{2} \Delta \sin L + B \cos l 2 \sin \frac{1}{2} d' \cos L.$

$Y' = (- (B \sin l - 0.0025) 2 \sin \frac{1}{2} \Delta \cos L + B \cos l 2 \sin \frac{1}{2} d' \sin L) \sin D$
 $- (A \cos l + 0.0021) 2 \sin \frac{1}{2} \Delta \cos D.$

As an extreme case, let us compute the immersion of 23 *Pleiadum* at Point Hudson, in Oregon, from that at San Francisco.

$\Delta = +10^\circ 19' 54''$	$T' = 9^h 49^m 2^s$
$d' = + 1^m 30^s$	$t = - 15 30$
$l = 42^\circ 57' 3''$	$L = 5 33 18$

The general equations for all transfers from San Francisco to Point Hudson become

$X' = [9.0879] \sin L + [7.6811] \cos L.$

$Y' = (-[9.0879] \cos L + [7.6811] \sin L) \sin D$
 $- [9.1189] \cos D.$

Original X, Y	-0.2718	-0.0160
	+0.1216	— 56
$X', Y' \left\{ \right.$	+ 6	+ 19
	—0.1208	—0.1208
	—0.1496	—0.1405
$\gamma = -500^\circ$	— 752	— 19
	—0.2218	—0.1424
-50°	— 75	— 2
	—0.2323	—0.1426
$+2^\circ$	+ 3	+ 0
Point Hudson X, Y	-0.2320	-0.1426

For greater accuracy and for verification, we will now assume $t = -24^m 40^s$, and compute the same immersion directly.

$H = +5^h 48^m 5^s$	$tp = -0.18$
$\tau = - 24 44$	$tq = -0.22$
$h = +5 23 21$	$p^2 = 0.18$
$w = 0.6813$	$x' = +1.40$
$t = -0.41$	$y' = +0.04$
$t^2 = 0.17$	

P, Z	+0.6544	-0.1490
	-0.2228	-0.0390
	+0.4316	-0.1880
	-0.6602	+ 430
$x, y,$	-0.2286	-0.1450
	+ 2	— 3
	+ 2	+ 1
	—0.2282	-0.1446
$\gamma = -20^\circ$	— 28	— 1
	-0.2310	-0.1447
-2°	+ 3	+ 0
$(Q = 302^\circ)$	-0.2307	-0.1447

$$\begin{array}{rcl}
 T+t & = & 9^h 24^m 22^s \\
 \gamma & = & -18 \\
 \text{Immersion,} & & 9 \ 24 \ 4
 \end{array}$$

The following coördinates are computed for $d = 3^h$, $\varphi = 40^\circ 43' 49''$, the correction s only being applied, and will be sufficiently accurate in most cases to transfer by the above method to any point in the United States where the occultations will be visible, for the preliminary computation.

Star.	T	x	y
n	$9^h 20^m$	$+0.0223$	$+0.5257$
14	30	-0.2208	-0.1520
17	31	-0.2477	-0.1086
25	38	-0.2669	$+0.0191$
16	39	-0.1730	-0.2059
19	39	-0.1906	-0.1910
23	40	-0.2080	-0.0537
26	9 42	-0.2575	$+0.0933$
22	10 1	-0.0083	-0.3130
28	12	-0.1502	$+0.2334$
16	19	$+0.1873$	-0.1933
14	20	$+0.2265$	-0.1362
19	24	$+0.2163$	-0.1767
17	27	$+0.2566$	-0.0906
23	33	$+0.2750$	-0.0371
34	38	-0.2479	-0.0831
25	38	$+0.2811$	$+0.0389$
26	38	$+0.2557$	$+0.1117$
28	10 42	$+0.1321$	$+0.2435$
34	11 30	$+0.2686$	-0.0631

Longitude.—Applying the corrections ζ, η to the computed coördinates for another station, we have the true coördinates, if the longitude has been assumed correctly. If not, add $\varepsilon p', \varepsilon q'$, so as to bring the moon's edge in contact with the star, and $d + \varepsilon$ will be the true longitude. Suppose, for instance, that the immersion of 23 *Pleiadum* should be observed at Point Hudson 40^s earlier than predicted above.

Predicted	X, Y	-0.2307	-0.1447
	$t''x, t''y$	-56	-2
Assumed	ζ, η	$+42$	$+11$
		-0.2321	-0.1438
	$\varepsilon = +6^s$	$+9$	$+2$
Observed	X, Y	-0.2312	-0.1436

These suppositions, therefore, would indicate a difference of longitude of $1^m 36^s$ between Point Hudson and Rincon Point.

Accurate Computation.—For the preliminary calculations, the accuracy of the above methods is all that can be desired. And after the observations the labor is so slight of obtaining at least a rough approximation to the errors of the tables and of the longitude, that even when it is intended to compute those errors to six or seven places of decimals, and by a more accurate method, it may be desirable to obtain corrected values of the moon's place and of the longitude to be used in the accurate computation. For the remaining errors will be so exceedingly small, if no error has been committed, that, having obtained the apparent coördinates accurately, three or four places of decimals will be amply sufficient for the remainder of the work.

New York, December, 1860.

ELEMENTS AND EPHEMERIS OF POLYMNIA FOR THE OPPOSITION IN 1861.

By ERNEST SCHUBERT.

[Communicated by Captain C. H. DAVIS, U. S. N., Superintendent Nautical Almanac.]

OSCULATING ELEMENTS.

1861, February 4.0, Washington M.T.

$$\begin{array}{rcl}
 M & = & 133^\circ 42' 6.3'' \\
 \pi & = & 341^\circ 23' 29.2'' \\
 \Omega & = & 9^\circ 7' 1.3'' \\
 i & = & 1^\circ 56' 46.9'' \\
 \varphi & = & 19^\circ 40' 6.4'' \\
 \mu & = & 728''.3732 \\
 \log a & = & 0.458435
 \end{array}
 \left. \begin{array}{l} \\ \\ \\ \\ \\ \end{array} \right\} \text{M. Eq. Ep.}$$

Washington Mean Midnight.	33 α	33 δ	Log Δ	Log r	Washington Mean Midnight.	33 α	33 δ	Log Δ	Log r
1861 Jan. 8	9 ^h 38 ^m 16.82 ^s	+16 [°] 21' 55.1"	0.43981	0.55882	1861 Feb. 10	9 ^h 12 ^m 19.12 ^s	+18 [°] 21' 45.7"	0.43031	
9	37 39.71	25 9.7	43878		11	11 28.65	25 8.7	43087	0.56533
10	37 1.61	28 28.0	43780	55923	12	10 38.50	28 28.6	43119	
11	36 22.56	31 49.8	43685		13	9 48.71	31 45.1	43215	56568
12	35 42.57	35 14.8	43595	55964	14	8 59.35	34 58.0	43286	
13	35 1.69	38 42.7	43508		15	8 10.44	38 7.2	43362	56603
14	34 19.93	42 13.5	43426	56005	16	7 22.02	41 12.7	43442	
15	33 37.34	45 46.8	43349		17	6 34.14	44 14.2	43528	56637
16	32 53.95	49 22.5	43275	56045	18	5 46.84	47 11.6	43618	
17	32 9.78	53 0.4	43207		19	5 0.16	50 4.8	43714	56672
18	31 24.88	16 56 40.3	43142	56084	20	4 14.12	52 53.8	43811	
19	30 39.28	17 0 22.0	43083		21	3 28.76	55 38.4	43914	56705
20	29 53.01	4 5.3	43028	56124	22	2 44.12	18 58 18.7	44022	
21	29 6.11	7 49.9	42978		23	2 0.24	19 0 54.4	44133	56739
22	28 18.63	11 35.7	42933	56163	24	1 17.13	3 25.6	44249	
23	27 30.60	15 22.3	42892		25	9 0 34.83	5 52.1	44369	56772
24	26 42.07	19 9.6	42857	56201	26	8 59 53.36	8 13.9	44493	
25	25 53.07	22 57.1	42826		27	59 14.75	10 31.0	44620	56804
26	25 3.65	26 44.8	42801	56240	28	58 33.03	12 43.1	44752	
27	24 13.84	30 32.5	42780		Mar. 1	57 54.24	14 50.4	44887	56837
28	23 23.67	34 20.0	42765	56277	2	57 16.40	16 52.8	45025	
29	22 33.19	38 7.1	42754		3	56 39.53	18 50.2	45167	56869
30	21 42.44	41 53.7	42749	56315	4	56 3.65	20 42.6	45313	
31	20 51.46	45 39.5	42749		5	55 28.78	22 30.1	45461	56900
Feb. 1	20 0.30	49 24.3	42754	56352	6	54 54.94	24 12.6	45613	
2	19 8.98	53 7.8	42764		7	54 22.15	25 50.2	45768	56932
3	18 17.56	17 56 49.8	42779	56389	8	53 50.13	27 22.6	45926	
4	17 26.10	18 0 30.4	42800		9	53 19.80	28 50.0	46087	56963
5	16 34.65	4 9.0	42826	56426	10	52 50.27	30 12.2	46251	
6	15 43.26	7 45.3	42856		11	52 21.87	31 29.3	46417	56994
7	14 51.97	11 19.3	42892	56462	12	51 54.60	32 41.2	46586	
8	14 0.82	14 50.8	42933		13	8 51 28.47	+19 33 48.0	0.46758	0.57024
9	9 13 9.86	+18 18 19.6	0.42980	0.56498					

8 1861, February 4, 7^h 36^m.1 Washington M. T. Intensity of light = 0.30.

OBSERVATIONS OF TITANIA.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — Corrected for refraction.]

Date.	Wash. M. T.	No. Comp.	Comparison Star.	$\Delta\alpha$ (60) — *	$\Delta\delta$ (60)'s Apparent	α	δ
1860, Sept. 15	9 ^h 39 ^m 14.3 ^s	10	B.A.C. 8084	—2 21.28	+ 0 19.57	23 4 37.28	—3 22' 56.84"
16	8 29 50.9	6	" 8084	—3 12.49	— 6 37.75	23 3 46.07	3 29 54.00
21	8 28 45.4	7	* 12	+1 56.41	+ 8 27.47	22 59 25.81	4 5 59.51
22	8 12 5.9	20	"	+1 7.03	+ 1 29.65	22 58 36.42	4 12 57.31
22	8 49 30.2	4	"	+1 5.63	+ 1 23.96	22 58 35.03	4 13 3.00
23	8 10 26.6	20	"	+0 17.22	— 5 22.27	57 46.61	4 19 49.22
25	7 40 35.7	4	"	—1 16.73	—18 49.05	56 12.68	4 33 15.95
28	8 30 20.1	4	N. Cat. Gen. 2776	+1 23.44	+12 49.85	53 54.51	4 53 28.48
29	8 10 20.2	8	"	+0 40.27	+ 6 25.89	22 53 11.33	—4 59 52.46

Date.	Wash. M. T.	No. Comp.	Comparison Star.	(60) — *		(60)'s Apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1860, Oct.	5	h m s 11 27 10.5	6 B.A.C. 7993	—0 52.10	— 3 32.75	22 49 14.40	—5 36 34.73
	6	7 26 36.3	14 " 7986	+0 45.19	+ 2 15.00	48 44.87	5 41 17.35
	10	8 41 42.8	13 Weisse, XXII. 957	+0 30.06	+ 3 3.03	46 43.80	6 1 45.33
	12	8 34 30.4	9 " 957	—0 20.92	— 6 12.06	45 52.80	6 11 0.39
	16	8 39 8.6	7 " 897	+1 28.57	— 5 57.24	44 31.53	6 26 6.46
Nov.	3	8 31 49.9	17 Rümker, 10641	+2 12.58	+10 11.43	44 8.75	7 4 33.97
	4	7 51 52.1	20 " 10641	+2 27.11	+ 9 43.76	44 23.27	7 4 51.65
	6	7 45 52.8	15 " 10641	+3 2.06	+ 9 39.61	44 58.19	7 4 55.91
	7	7 42 21.3	6 Weisse, XXII. 962	—1 7.64	—13 52.83	45 17.71	7 4 37.47
	8	7 57 25.9	8 " 962	—0 45.73	—13 31.28	45 39.60	7 4 15.96
	11	7 42 31.9	10 " 962	+0 28.31	—11 2.15	46 53.59	7 1 46.96
	12	7 28 22.3	15 " 962	+0 55.88	— 9 55.84	47 21.15	7 0 40.68
	13	7 50 44.1	16 " 962	+1 25.95	— 8 34.26	47 51.20	6 59 19.14
	14	7 37 7.4	12 " 962	+1 56.80	— 7 7.51	48 22.03	6 57 52.44
	15	7 42 4.9	7 " 962	+2 29.49	— 5 22.99	22 48 54.70	6 56 7.96
Dec.	4	8 6 19.0	6 " XXIII. 45	—0 32.05	— 2 39.77	23 3 34.40	5 53 48.82
	11	8 15 57.3	4 " 179	+0 40.83	— 5 56.45	10 46.42	5 17 27.44
	12	7 49 14.2	14 " 179	+1 45.87	— 0 22.86	23 11 51.46	—5 11 51.45

Mean Places of Comparison-Stars for 1860.

*	Mag.	α	Authority.	δ	Authority.
B.A.C. 8084	7	h m s 23 6 54.19	Y ¹ .	—3 23 41.76	Y ³ .
* 12	9	22 57 25.01	Y ₁ .	4 14 53.04	L ₁ .
Σ Cat G. 2776	8	22 52 26.67	Y ₁ .	5 6 41.08	L ₁ .
B.A.C. 7993	7	22 50 2.13	} Brit. A. Catalogue.	5 33 27.45	} B. A. Catalogue.
B.A.C. 7986	7	22 47 55.33		5 43 57.67	
Weisse, XXII. 957	9	22 46 9.41	Y ₁ .	6 5 13.28	L ₁ .
" " 897	9	22 42 58.68	Weisse's Catalogue.	6 20 33.85	Weisse's Catalogue.
Rümker, 10641	9	22 41 52.07	Y ₁ .	7 14 58.84	L ₂ .
Weisse, XXII. 962	9	22 46 21.27	Y ₂ .	6 51 8.10	Y ₃ .
Weisse, XXIII. 45	9	23 4 2.70	Y ₁ .	5 51 33.32	Weisse's Catalogue.
" " 179	9	23 10 1.81	Weisse's Catalogue.	—5 11 51.64	" "

The places of the stars marked Y, L have been determined by Professors YARNALL and LAWRENCE, with the transits and mural of the Observatory.

Washington, December 17, 1860.

FROM A LETTER OF MR. MASTERMAN TO THE EDITOR.

I HAVE observed late Maxima and Minima of α *Herculis* and R *Scuti*, as follows:—

Star.	Date.	Condition of Light.	Comparative Brightness.
α <i>Herculis</i>	1860, Aug. 28	Maximum	α $\frac{3}{4}$ β <i>Ophiuchi</i> .
	Oct. 25	Minimum	α 1 δ <i>Herculis</i> .
	Nov. 13	Maximum	β <i>Ophiuchi</i> 1 $\frac{1}{2}$ α .
R <i>Scuti</i>	Aug. 31	Maximum	R 3 <i>h Aquilæ</i> .
	Oct. 13	Near a Minimum	Just visible to the naked eye.
	Nov. 7	Maximum	R = 7 H <i>Scuti</i> .

STILLMAN MASTERMAN.

Weld, Me., 1860, December 10.

CORRIGENDA.

A. In the *Astronomical Journal*, Vol. VI.

Page 78, col. 3, heading, for δ , read α .

" 146, " 1, line 29, " of the single, read by the single.

" 156, " 2, " —5, " N. 75° or 78° W., read S. 75° or 78° W.

" 158, " 1, " —8, " radius-vectors were, read radius-vector was.

" 164, " 2, " 2, " 2^m 55.4, read 1^m 55.4.

" 168, " 2, " 19, " +70° for α Orionis to —3° for δ Leonis, read +7° for α Orionis to —3° for δ Leonis.

B. In DAVIS's Translation of GAUSS's *Theoria Motus*.

The following errors have been detected and communicated by Mr. CLEVELAND ABBE, excepting two, which Capt. DAVIS has added to the list. Those marked with a * exist also in the original work.

Page 30, line —3, for $\log(45^\circ + \frac{1}{2}F)$, read $\log \tan(45^\circ + \frac{1}{2}F)$.*

" 33, " 11, " 206265, " 206265". *

" 35, " —8, " $\frac{(u-1)\tan\frac{1}{2}\psi}{u+1}$, " $\frac{u-1}{(u+1)\tan\frac{1}{2}\psi}$. *

" 45, " 16, " $\tan\frac{1}{2}w^3$, " $\tan^3\frac{1}{2}w$. *

" 49, " 4, " $e = 0.9674567$, " $e = 0.96764567$.

" 84, lines 5, 6, 7 should read

"The time $t-T$ will be the product of the distance Pa into 493', within which time light traverses the mean distance of the earth from the sun, which distance we take as unity."

Page 85, line —7, for mean, read apparent. *

" 108, " 2, for $\cotan\frac{1}{2}(N''-N)$, read $\cotan\frac{1}{2}(N''-N')$.*

" 112, " 9, " $\frac{\Delta^2\sqrt{rr'}}{18a^2}$, read $\frac{\Delta^2\sqrt{rr'}}{18a^2}$.

" 122, lines —7, 8, for logarithms computed, read logarithms of y^2 computed.

" 124, line 12, for $\frac{k^2t^2}{4y^2rr'\cos^2f\sin^2g}$, read $\frac{k^2t^2}{4y^2rr'\cos^2f\sin^2g}$.

" 125, " —12, in the denominator, for $\cos^2\frac{1}{2}(f-g)$, read $\cos^2\frac{1}{2}(f+g)$.

" 134, " —11, " Art. 19, " Art. 91.

" 143, lines 6, 8, " log., read hyp. log.

Page 266, line 11, for $e^{-hh''\sigma\sigma}$, read $e^{-\frac{hh''\sigma\sigma}{c^2}}$.

" 272, " 15, " $D'+\delta$, " $D'+\delta'$.

" 282, " —11, " $25\tan^3\frac{1}{2}v$; read $25\tan^3\frac{1}{2}v$;

" 286, " 14, " B , " B' .

" 287, " —6, " da , " du .

" 288, " 9, " q^2 , " r^2 .

" " " —5, the numerator of the first fraction should be doubled.

" 290, " —1, for $\sin A$, read $\cos A$.

" 291, " —1, " $\sin(\pi-\Omega)$, read $\cos(\pi-\Omega)$.

" 292, " 9, " a , " a .

" " " 12, for $A(1-e\sec E)$, read $A\cos E(1-e\sec E)$.

" " " 13, " $A'(1-e\sec E)$, " $A'\cos E(1-e\sec E)$.

" " " 14, " $A'''(1-e\sec E)$, " $A'''\cos E(1-e\sec E)$.

" 293, " 4, " $\log a$, " $\log a$.

" " " —11, for $\log\frac{1}{c}$, " $\log\frac{1}{c'}$.

" 299, " 10, " subtract from it, read subtract it from.

" " " 12, " $dy\sin\alpha$, " $dy\cos\alpha$.

" " " —3, " $\cos\alpha$, " $\cos\alpha$.

" 300, " 3, " $\cos\alpha$, " $\cos\alpha$.

" 312, " 16, " $\sin(z-z)$, " $\sin(z-q)$.

" 322, " —3, " $q\tan\beta$, " $q'\tan\beta'$.

" 323, " 14, " $g\cos\psi$, " $g\cos\varphi$.

The last of these corrections is also to be made in OLBERS's *Abhandlung*, p. 247.

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FROM A LETTER OF MR. MASTERMAN TO THE EDITOR.

CORRIGENDA.

ADVERTISEMENT.

THE ASTRONOMICAL JOURNAL. No. 144.

VOL. VI.

CAMBRIDGE, 1861, FEBRUARY 9.

NO. 24.

ELEMENTS AND EPHEMERIS OF TITANIA.

By JAMES FERGUSON.

The elements are computed from the following observations : —

	Washington M.T.	α	δ
	^h ^m ^s	^h ^m ^s	
1860, Sept. 15	9 39 14.3	23 4 37.38	—3 22' 56".84
Oct. 10	8 41 42.8	22 46 43.80	6 1 45.33
Nov. 4	7 51 52.3	22 44 23.27	7 4 51.65

October 0.1860, Washington M.T.

$$M = 278^{\circ} 11' 24.5''$$

$$\pi = 96 49 14.4''$$

$$\Omega = 192 3 25.0'' \quad \left. \begin{array}{l} \pi \\ \Omega \end{array} \right\} \text{M. Eq. Oct. 0.1860.}$$

$$i = 6 33 26.6$$

$$q = 11 3 57.5$$

$$\log a = 0.3810974$$

$$\log \mu = 2.9783602$$

EPHEMERIS FOR WASHINGTON MEAN NOON.

Date.	(60) α	(60) δ	$\log r$	$\log \Delta$	Date.	(60) α	(60) δ	$\log r$	$\log \Delta$
	^h ^m ^s	[°] ['] ^{''}				^h ^m ^s	[°] ['] ^{''}		
1860 Dec. 15	23 15 0	—1 55' 33"	0.35504	0.33314	1861 Jan. 1	23 36 47	—2 53' 59"		
16	16 10	49 20			2	38 11	46 57		
17	17 21	43 3			3	29 35	38 49		
18	18 33	36 35			4	23 41 0	2 30 34	0.34723	0.37208
19	23 19 46	4 30 4	0.35385	0.34166	5	42 27	22 23		
20	20 59	23 25			6	43 53	14 5		
21	22 14	16 39			7	45 21	5 43		
22	23 30	9 48			8	23 46 48	1 57 14	0.34557	0.37911
23	23 24 46	4 2 47	0.35220	0.34950	9	48 17	48 36		
24	26 3	3 55 40			10	49 46	39 55		
25	27 21	48 27			11	51 16	31 7		
26	28 39	41 7			12	23 52 47	1 22 17	0.34392	0.38577
27	23 29 58	3 33 41	0.35054	0.35773	13	54 18	13 20		
28	31 19	26 9			14	55 50	4 19		
29	32 40	18 31			15	57 22	0 55 12		
30	34 1	10 46			16	23 58 56	—0 46 1	0.34228	0.39228
31	23 35 24	—3 2 54	0.34889	0.36493					

The planet on the 12th of December was less than the 14 magnitude ; the correction to the Ephemeris on that day being in right-ascension —5".2, in declination —39".0.

ELEMENTS AND EPHEMERIS OF IRIS FOR THE OPPOSITION OF 1861.

BY ERNEST SCHUBERT.

[Communicated by Captain C. H. DAVIS, U. S. N., Superintendent Nautical Almanac.]

PERTURBATIONS BY JUPITER AND SATURN.

	δi	$\delta \Omega$	$\delta \varphi$	$\delta \pi$	$\delta \mu$	$f \delta \mu$	δM
$\mathcal{M}$	-20.49	- 621.69	+ 64.80	- 870.77	+0.23946	- 430.15	+ 412.96
$\mathcal{h}$	+ 0.73	- 27.05	+ 3.40	+ 19.29	+0.02414	+ 32.71	- 43.73
$\mathcal{M} + \mathcal{h}$	-19.76	-10 48.74	+1 8.20	-14 11.48	+0.26360	-6 37.44	+6 9.23

OSCULATING ELEMENTS.

1861, May 12.0, Washington M.T.

$$M = 196^{\circ} 12' 56.7''$$

$$\pi = 41^{\circ} 23' 9.6''$$

$$\Omega = 259^{\circ} 47' 26.1''$$

$$i = 5^{\circ} 27' 57.2''$$

$$\varphi = 13^{\circ} 22' 52.8''$$

$$\mu = 963''.1276$$

$$\log a = 0.377549$$

EPHEMERIS FOR WASHINGTON MEAN MIDNIGHT.

1861.	α	δ	$\log \Delta$	$\log r$	1861.	α	δ	$\log \Delta$	$\log r$
	^h ^m ^s	[°] ['] ^{''}				^h ^m ^s	[°] ['] ^{''}		
April 10	15 40 38.06	-23 58 28.8	0.316585	0.467461	May 13	15 12 15.78	-21 54' 56.3	0.281633	
11	40 2.96	56 30.1	314721		14	11 16.18	49 41.0	281602	0.465618
12	39 26.41	54 24.5	312893	467391	15	10 16.81	44 22.9	281636	
13	38 48.44	52 11.9	311108		16	9 17.73	39 2.3	281735	465467
14	38 9.07	49 52.3	309362	467316	17	8 19.00	33 39.6	281900	
15	37 28.37	47 25.7	307657		18	7 20.69	28 15.0	282130	465311
16	36 46.37	44 52.1	305996	467235	19	6 22.84	22 48.9	282424	
17	36 3.09	42 11.1	304379		20	5 25.51	17 21.5	282781	465151
18	35 18.57	39 23.7	302809	467150	21	4 28.76	11 53.0	283201	
19	34 32.84	36 28.8	301286		22	3 32.65	6 23.8	283684	464985
20	33 45.95	33 26.9	299812	467061	23	2 37.21	21 0 54.1	284229	
21	32 57.94	30 18.0	298387		24	1 42.51	20 55 24.4	284836	464815
22	32 8.85	27 2.1	297013	466967	25	15 0 48.60	49 55.2	285504	
23	31 18.71	23 39.5	295691		26	14 59 55.51	44 26.6	286232	464641
24	30 27.63	20 10.0	294422	466869	27	59 3.29	38 59.0	287019	
25	29 35.57	16 33.8	293207		28	58 11.99	33 32.7	287864	464462
26	28 42.60	12 50.8	292047	466764	29	57 21.65	28 7.8	288766	
27	27 48.74	9 1.2	290943		30	56 32.31	22 44.8	289724	464278
28	26 54.06	5 5.0	289895	466655	31	55 41.02	17 23.9	290737	
29	25 58.62	23 1 2.5	288905		June 1	54 56.83	12 5.5	291805	464090
30	25 2.49	22 56 53.8	287975	466541	2	54 10.78	6 49.8	292926	
May 1	24 5.71	52 39.2	287106		3	53 25.89	20 1 37.2	293499	463896
2	23 8.34	48 18.6	286298	466424	4	52 12.20	19 56 28.0	295323	
3	22 10.44	43 52.4	285553		5	51 59.73	51 22.4	296596	463698
4	21 12.07	39 20.5	284871	466302	6	51 18.50	46 20.8	297918	
5	20 13.27	34 43.1	284251		7	50 38.56	41 23.5	299287	463495
6	19 14.12	30 0.5	283695	466175	8	49 59.94	36 30.5	300702	
7	18 14.69	25 12.9	283203		9	49 22.67	31 42.2	302162	463287
8	17 15.04	20 20.5	282776	466043	10	48 46.78	26 58.8	303665	
9	16 15.23	15 23.6	282416		11	48 12.30	22 20.4	305209	463074
10	15 15.31	10 22.5	282122	465906	12	47 39.26	17 47.2	306793	
11	14 15.42	5 17.4	281893		13	14 47 7.68	-19 13 19.4	0.308416	0.462857
12	15 13 15.55	-22 0 8.5	0.281730	0.465765					

g 1861, May 12, 0^h 49^m.8 Washington M. T. Intensity of light = 0.35.

OBSERVATIONS OF VARIABLE STARS,

MADE AT WELD, FRANKLIN COUNTY, MAINE.

By STILLMAN MASTERMAN.

ALGOL-MINIMA.

No. of Period.	Observed Washington M. T. of Minimum.		
		h	m s
+7732	1860, September 13	15	52 36
7733	16	12	52 31
7740	October 6	11	26 14
7763	December 11	13	9 21
7764	14	9	51 15
+7765	17	6	48 40

Dec. 11: Observation not very good; atmosphere somewhat unfavorable.

MIRA CETI.

Time of Maximum Brightness, 1860, September 15.

Date.			Comparison.	Date.			Comparison.
1860, July			<i>Mira</i> about the brightness of γ Ceti.	1860, October			α 3 o, o 3 γ .
22	14.75	h		12	12.0		α 3 o, o 3 γ .
23	14.7			13	12.0		α 3 $\frac{1}{2}$ o, o 2 $\frac{1}{2}$ γ .
24	14.6			16	14.5		o 1 γ , o 5 α Piscium.
25	14.7			18	9.5		o $\frac{3}{4}$ γ , o 4 $\frac{1}{2}$ α Piscium.
30	14.5			19	11.4		γ $\frac{3}{4}$ o, o 4 α Piscium.
31	14.75			25	9.5		α Pis. 1 o, o 2 δ .
August	1	15.0		November	1	9.0	α Pis. 3 o, δ = o (?).
	4	14.0		5	8.2		δ 1 o.
	5	15.0		8	10.0		δ 2 o.
	15	14.1		9	7.5		o = μ , ξ 1 o.
	17	14.6		13	9.0		μ 1 $\frac{1}{2}$ o, o 3 $\frac{1}{2}$ λ .
	22	14.5		14	8.0		μ 2 $\frac{1}{2}$ o, o 2 $\frac{1}{2}$ λ .
	26	14.5		16	8.0		μ 3 o, o 2 λ .
	28	15.2		17	7.6		μ 4 o, o 1 λ .
	30	14.5		20	8.0		o = λ .
	31	13.4		22	7.5		λ 1 o, o 3 75.
September	2	13.3	α 1 o, o 1 β Arctis.	27	9.0		λ 2 o, o 2 75.
	3	14.0		28	8.0		λ 2 o, o 2 75.
	9	13.5		29	8.0		λ 3 o, o 1 75.
	13	15.2		December	3	8.0	o 2 70.
	14	14.8		6	8.5		o 2 70, 75 1 o.
	15	14.0		7	9.0		o 1 $\frac{1}{2}$ 70, 75 2 o.
	16	13.0		8	8.5		o $\frac{1}{2}$ 70.
	17	13.5		11	9.0		o = 70.
	18	14.3		12	8.5		70 3—2 o.
	21	14.5		14	9.0		(70 3 o; o distinctly visible to
October	23	12.5	α 2 o, o 4 γ , β Ar. 2 o.	17	8.1		the naked eye.
	29	12.0		18	8.0		70 3 $\frac{1}{2}$ o.
	30	12.0		28	7.0		{ o and 396 B invisible to the na-
	5	13.0		29	5.75		ked eye; 70 distinctly visible.
	6	14.0					
	10	11.0					

To my eye the star appeared quite red down to the sixth magnitude, but with a somewhat diminished intensity after passing the fourth magnitude. By the use of a small telescope, I find that stars of between the fifth and sixth magnitude, which are decidedly red, appear, in several instances, as perfectly white stars to my eye alone. This, I think, may account for my observing a decrease in the redness of *Mira* corresponding to the diminution in its brightness. In the telescope, *Mira* at the sixth magnitude appears to have lost none of its redness.

OBSERVATIONS OF TITANIA AND EUPHROSYNE.

MADE WITH THE FILAR-MICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — Corrected for refraction.]

TITANIA.

Date.	Wash. M. T.	No. Comp.	Comparison Star.	(60) — *		(60)'s Apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1860, Dec. 31	^h 7 ^m 46 ^s 8.4	3	* 13	^m —0 42.56	^s + 0' 27.40	^h 23 ^m 35 ^s 35.56	[^] —3 ['] 1' 54.62
1861, Jan. 4	7 59 42.8	3	Weisse, XXIII. 809	+0 55.86	—12 48.46	23 41 11.42	2 29 41.25
5	7 24 48.5	5	"	+2 20.08	—4 43.75	23 42 35.03	—2 21 36.39

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	δ	Authority.
* 13	9.5	^h 23 ^m 36 ^s 14.42	[^] —3 ['] 2' 45.48	Washington Equatorial.
Weisse, XXIII. 809	9	23 40 11.88	—2 17 16.20	Weisse's Catalogue.

These comparisons of Titania were made with great difficulty, the planet being very faint.

EUPHROSYNE.

Date.	Wash. M. T.	No. Comp.	Comparison Star.	(31) — *		(31)'s Apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1860, Oct. 24	^h 9 ^m 19 ^s 45.2	10	B. Z. 402, 13	^m +1 33.68	^s + 6' 29.66	^h 3 ^m 44 ^s 7.17	[^] +34 ['] 17' 31.18
25	8 46 29.9	20	" 402, 10	+1 11.87	—12 34.02	3 43 9.66	34 27 58.59
26	8 28 32.6	10	" "	+0 12.52	—2 8.81	3 42 10.34	34 38 23.91
26	8 51 0.1	10	" "	+0 11.64	—1 58.12	9.46	34.60
26	9 12 53.6	10	" "	+0 10.66	—1 47.79	8.48	44.84
26	9 32 44.5	10	" "	+0 9.72	—1 40.30	7.53	52.43
Nov. 12	9 0 23.5	10	" 508, 101	—1 50.81	+10 58.68	3 21 8.33	37 11 3.49
13	9 15 35.4	4	" 508, 94	+1 14.02	—15 24.62	3 19 43.41	37 18 8.60
14	8 42 32.3	10	" "	—0 8.42	—8 46.95	3 18 20.92	37 24 46.36
15	8 43 44.1	10	" "	—1 32.38	—2 15.87	3 16 56.97	37 31 17.62
24	7 45 40.8	10	" 448, 4	+0 10.53	—8 39.73	3 4 23.26	38 18 23.12
28	7 39 43.9	10	B.A.C. 953	+2 43.79	+14 59.63	2 59 2.65	+38 33 10.65

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
B. Z. 402, 13	8	^h 3 ^m 42 ^s 27.98	Y ₁ .	[^] +34 ['] 10' 46.71	L ₁ .
" 402, 10	8.9	3 41 52.25	Bessel's Zones.	34 40 14.65	L ₂ .
" 508, 101	9	3 22 53.21	Y ₁ .	36 59 42.61	L ₁ .
" 508, 94	8	3 18 23.38	Y ₁ .	37 33 10.30	L ₃ .
" 448, 4	9	3 4 6.83	Y ₁ .	38 26 35.83	L ₃ .
B.A.C. 953	4	2 56 12.89	Y ₁ .	+38 17 43.35	All known observat'ns.

The stars having Y and L opposite them have been determined by Professors YARNALL and LAWRENCE, with the mural and transit of the Observatory.

CORRECTION. — At page 183 of the Journal, Vol. VI, in the Observations of *Titania* opposite Oct. 16, for —5' 57".24 read —7' 23".68; and for —6° 26' 6".46 read —6° 27' 32".87.

Washington, February 6, 1861.

OBSERVATIONS OF MARS, EUROPA, IRENE, AND EUNOMIA.

MADE WITH THE FILAR-NICROMETER OF THE WASHINGTON EQUATORIAL.

By JAMES FERGUSON.

[Communicated by Commander M. F. MAURY. — Corrected for refraction.]

MARS.

Date.	M. T. Washington.	No. of Comp.	Comparison Star.	Mars — *		Mars's apparent	
				$\Delta\alpha$	$\Delta\delta$	α	δ
1860, July 14	h m s 10 0 29.9	7	B.A.C. 6888	$-0^m 43.28^s$	$+17' 30.57''$	19 56 0.46	$-26^\circ 54' 42.28''$
14	3 16.1	7	" "	.29	17 59.10	.35	54 12.75
20	9 31 51.5	8	" 6832	$+0 24.53$	$+ 6 30.25$	48 50.40	27 25 37.32
20	33 39.4	8	" "	.45	7 0.92	.31	25 6.65
21	9 24 38.3	12	" "	$-0 47.17$	$+ 2 4.19$	47 37.49	30 3.14
21	26 31.2	12	" "	.23	2 35.16	.42	30 31.27
27	9 45 19.7	7	" 6792	$-1 56.06$	$- 2 20.90$	40 39.66	51 35.11
27	45 48.8	6	" "	.08	1 51.62	.67	51 5.84
31	9 45 45.6	3	A.C. 19901	$+0 46.87$	$- 2 30.43$	36 34.92	28 0 39.43
31	47 55.9	3	" "	.88	2 2.25	.93	0 11.25
Aug. 1	8 59 14.8	6	" "	$-0 7.52$	$- 4 3.51$	35 40.59	2 12.56
1	9 1 15.0	6	" "	.55	3 34.10	.53	1 43.14
6	8 28 26.3	5	" 19845	$-0 35.31$	$- 5 25.12$	31 36.62	6 10.10
6	31 39.6	5	" "	.33	4 58.77	.60	5 43.76
7	8 28 44.7	6	" "	$-1 15.05$	$- 5 29.36$	30 56.78	6 14.38
7	31 14.3	6	" "	.30	5 2.33	.50	5 47.35
9	9 2 42.1	6	" "	$-2 26.71$	$- 4 46.96$	29 45.43	5 32.07
9	6 34.5	6	" "	.78	4 22.31	.28	28 5 7.42
14	7 52 28.6	9	" 19730	$+0 53.21$	$- 3 48.19$	27 50.32	27 59 41.85
14	54 39.6	9	" "	.25	3 22.59	.37	59 16.23
15	8 39 13.2	9	" "	$+0 40.42$	$- 1 55.21$	27 37.54	57 49.41
15	41 13.0	9	" "	.37	1 30.03	.42	57 24.22
16	8 44 29.3	9	" "	$+0 31.09$	$+ 0 4.95$	27 28.17	55 49.29
16	46 56.0	9	" "	.06	0 29.05	.14	55 25.19
17	9 29 3.7	8	" "	$+0 25.21$	$+ 2 30.30$	27 22.24	53 23.98
17	32 37.9	8	" "	.11	2 53.73	.10	53 0.55
25	8 36 20.0	7	* 14	$-0 57.20$	$+11 40.81$	28 8	28 4
25	37 32.7	7	" "	.64	12 4.13	28 8	28 4
25	8 50 35.8	3	A.C. 19809	$-1 30.93$	$+12 34.46$	28 49.88	28 23.14
25	46 31.4	4	" "	31.14	12 56.92	.65	28 2.87
29	8 27 10.1	6	* 15	$+0 48.46$	$-13 39.39$	30 9	11 7
29	29 23.5	6	" "	.46	13 15.21	30 0	11 7
30	8 5 21.8	3	A.C. 19907	$-4 41.19$	$+ 0 53.94$	31 38.57	7 13.19
30	11 27.0	3	" "	40.93	1 15.41	.81	27 6 51.73
Sept. 1	8 13 21.1	5	" 19873	$-0 42.27$	$-11 32.06$	19 33 9.28	26 57 29.64
	15 43.5	5	" "	.15	10.60	.39	26 57 8.19

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag.	α	Authority.	δ	Authority.
B.A.C. 6888	7	h m s 19 56 39.09	Brit. Ass. Catalogue.	$-27^\circ 12' 20.94''$	Y ₂ .
" 6832	5	19 48 21.11	Green. 12 Y. Cat.	27 32 14.79	Green. 12 Y. Cat.
" 6792	7	19 42 32.05	Brit. Ass. Catalogue.	27 49 20.65	Y ₂ .
A.C. 19901	7	19 35 42.11	Argelander's Catalogue.	27 58 14.39	Y ₂ .
" 19845	7	19 32 8.09	" "	28 0 49.66	Y ₂ .
" 19730	9	19 26 51.36	" "	27 55 57.88	Argelander's Cat.
" 19809	8.5	19 30 16.86	" "	27 41 1.26	Y ₂ .
" 19907	9	19 36 15.79	" "	27 8 11.36	Y ₁ .
" 19873	8	19 33 47.64	" "	$-26 46 1.54$	Argelander's Cat.

In these comparisons of *Mars*, the power of the eye-piece used was 400—. Both limbs were observed on all the transit-wires, and the north and south limbs alternately on the decli-

nation-wires. The thickness of the wires, estimated at 0.^u3, is to be taken from the observed diameter of the planet.

EUROPA.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽⁵²⁾ — *	$\Delta\delta$ ⁽⁵²⁾ — *	α ⁽⁵²⁾ 's apparent	δ ⁽⁵²⁾ 's apparent
1860, July 24	^h 10 ^m 20 ^s 4.4	2	A.C. 20388	^m ^s +0 42.56	['] ["] — 6 56.61	^h ^m ^s 20 11 29.84	[°] ['] ["] —18 24 6.72
25	9 1 14.7	19	" "	—0 1.70	—10 58.21	20 10 45.59	18 28 8.28
27	9 49 48.5	20	" 20378	—0 49.87	+ 5 2.47	20 9 12.89	—18 36 25.41

IRENE.

Date.	M. T. Washington.	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽¹⁴⁾ — *	$\Delta\delta$ ⁽¹⁴⁾ — *	α ⁽¹⁴⁾ 's apparent	δ ⁽¹⁴⁾ 's apparent
1860, Aug. 7	^h 9 ^m 31 ^s 35.8	3	A.C. 21492	^m ^s +0 39.48	['] ["] + 4 24.11	^h ^m ^s 21 28 38.85	[°] ['] ["] —26 12 40.67
9	10 3 9.8	3	" 21497	—1 45.80	+ 2 24.42	21 26 45.03	26 24 32.56
14	9 58 34.6	5	" 21404	+1 50.35	+16 45.47	21 22 4.50	26 51 31.42
15	9 39 56.4	20	" "	+0 55.56	+11 51.21	21 21 9.71	26 56 25.73
16	9 46 7.6	15	" "	—0 0.9	+ 7 3.23	21 20 14.03	—27 1 13.76

EUNOMIA.

Date.	M. T. Washington	No. of Comp.	Comparison-Star.	$\Delta\alpha$ ⁽¹⁵⁾ — *	$\Delta\delta$ ⁽¹⁵⁾ — *	α ⁽¹⁵⁾ 's apparent	δ ⁽¹⁵⁾ 's apparent
1860, Aug. 29	^h 9 ^m 31 ^s 48.6	14	Weisse, XXI. 916	^m ^s +0 13.32	['] ["] + 1 17.57	^h ^m ^s 21 38 29.21	[°] ['] ["] —0 49 26.72
30	9 18 54.6	12	" "	—0 41.49	+ 0 35.52	21 37 44.50	0 50 8.69
Sept. 1	9 14 26.9	2	" "	—2 30.48	— 1 13.60	21 35 45.51	0 51 57.65
5	8 46 32.8	4	Σ 2611	+1 53.62	+ 4 41.95	21 32 20.29	—0 55 54.60

Mean Places, for 1860.0, of Comparison-Stars.

*	Mag	α	δ	Authority.
A.C. 20388	7.5	^h ^m ^s 20 10 42.82	[°] ['] ["] —18 17 20.02	Argelander's Catalogue.
" 20378	8	20 9 58.27	18 41 37.71	
" 21492	9	21 27 54.62	26 17 22.76	
" 21497	9	21 28 26.05	26 27 14.77	
" 21404	8.5	21 20 9.29	27 8 33.80	Weisse's Catalogue. Struve Cat. Gen.
Weisse, XXI. 916	9	21 38 11.75	0 51 4.64	
Σ 2611	6.4	21 30 22.44	— 1 0 56.98	

Washington, February, 1861.

FROM A LETTER OF PROFESSOR HOEK TO THE EDITOR.

Utrecht, Observatory Zonnenberg, 1861, January 12.

I send you with this an Ephemeris of *Proserpine* (26) for the opposition which will take place 1861, February 6. The Elements from which it is computed are these : —

$$\begin{aligned}
 M &= 306^{\circ} \ 3' \ 54.06 \\
 \pi &= 235 \ 18 \ 6.12 \\
 \Omega &= 45 \ 33 \ 53.89 \\
 i &= 3 \ 35 \ 40.32 \\
 \varphi &= 5 \ 1 \ 15.66 \\
 \mu &= 819''.68154 \\
 \log a &= 0.4242410 \\
 \text{Epoch} &= 1857, \text{ March } 20.0, \text{ Berlin M.T.}
 \end{aligned}
 \left. \begin{array}{l} \Omega \\ i \\ \varphi \end{array} \right\} \text{Mean Eq. 1858.0}$$

The perturbations by *Jupiter* and *Saturn* are accurately taken into account, and I am therefore in hopes of a good agreement with the heavens.

M. HOEK.

EPHEMERIS OF PROSERPINE FOR THE OPPOSITION OF FEBRUARY, 1861.

Berlin Mean Midnight						Berlin Mean Midnight					
App. α 26			App. δ 26			App. α 26			App. δ 26		
h	m	s	h	m	s	h	m	s	h	m	s
1861, Jan. 16	9	27	8.76	+20	49	22.0	0.430564	0.244196	1861, Feb. 5	9	9
17	26	22.38	54	5.3	0421	2803			6	8	2.35
18	25	34.79	58	50.1	0278	1473			7	7	3.72
19	24	46.07	+21	3	36.0	0135	0206		8	6	5.27
20	23	56.27	8	22.8	0.429992	0.239004			9	5	7.09
21	23	5.45	13	10.0	9849	7869			10	4	9.24
22	22	13.66	17	57.2	9706	6801			11	3	11.80
23	21	20.97	22	44.0	9562	5800			12	2	14.84
24	20	27.41	27	30.1	0.429418	0.234868			13	1	18.44
25	19	33.06	32	15.0	9274	4005			14	0	22.69
26	18	37.98	36	58.4	9130	3213			15	8	59
27	17	42.23	41	40.0	8986	2492			16	58	33.35
28	16	45.86	46	19.5	0.428842	0.231842			17	57	39.89
29	15	48.95	50	56.5	8698	1264			18	56	47.30
30	14	51.55	55	30.5	8553	0760			19	55	55.67
31	13	53.74	+22	0	1.1	8409	0329		20	55	5.06
Feb. 1	12	55.59	4	27.9	0.428264	0.229972			21	54	15.51
2	11	57.19	8	50.7	8118	9689			22	53	27.09
3	10	58.59	13	9.2	7973	9482			23	52	39.85
4	9	59.07	17	23.0	7828	9348			24	51	53.85
5	9	9	1.10	+22	21	31.8	0.427682	0.229288	25	8	51
										9.16	+23
										20	33.7
											0.424746
											0.242894

LETTER FROM MR. ASAPH HALL TO THE EDITOR.

Cambridge, 1861, January 13.

I TAKE the liberty to send you Elements of *Titania*. I computed elements some time ago, but owing to an error in the Washington observation of October 16, they were quite wrong. Mr. FERGUSON has sent me a correction of the observation.

I send also some typographical errors in Captain DAVIS's translation of the *Theoria Motus*, which are not included in Mr. ABEE's list.

A. HALL.

ELEMENTS OF TITANIA.

BY A. HALL.

1860, Sept. 15.0. Washington M.T.

$$\begin{aligned}
 M &= 275^{\circ} 16' 39''.6 \\
 \pi &= 95 \ 56 \ 56.9 \\
 Q &= 192 \ 3 \ 13.1 \\
 i &= 3 \ 33 \ 31.8 \\
 \varphi &= 11 \ 21 \ 9.1 \\
 \mu &= 940''.730 \\
 \log a &= 0.384361
 \end{aligned}
 \left. \vphantom{\begin{aligned} M \\ \pi \\ Q \\ i \\ \varphi \\ \mu \\ \log a \end{aligned}} \right\} 1860.0$$

I add the following list of typographical errors in Captain DAVIS's translation of the *Theoria Motus*, which are not included in the list given by Mr. ABEE, in No. 143 of the *Astronomical Journal*.

Page 48, line 3, for $\tan \frac{1}{2} v \sqrt{\frac{1+C}{\gamma(1+\frac{1}{5}T)}}$, read $\frac{\tan \frac{1}{2} v}{\gamma} \sqrt{\frac{1+C}{1+\frac{1}{5}T}}$.
 " 73, line 4, for R , read $\log R$.
 " 81, " -2, " $\sin(B-\theta)$, " $\sin(\beta-\theta)$.
 Page 88, line 6, for L' , read L .
 " 128, " 8, " 27 and 29, " 27 and 28.
 " 134, " -8, for " Instead of p ," read " For computing p ."
 " 151, " 10, for a^3 , read a^2 .
 " 184, " 3, " $r' r''$, " $r' r'$.
 " 204, " -5, " $0^{\circ}.1$ or $0^{\circ}.2$, " $0^{\circ}.1$ or $0^{\circ}.2$.
 " 210, " -11, " 110° , " 210° .
 " 314, " -2, " $\sin a$, " $\sin \beta$.
 " 325, " -9, " $\cos(L'''-L')$, read $\cotan \frac{1}{2}(L'''-L')$.

ON THE MEAN PLACES OF STANDARD CIRCUMPOLAR STARS.

By B. A. GOULD.

[From a Report to PROFESSOR BACHE, Supt. U. S. Coast Survey.]

IN No. 121 and subsequent numbers of the *Astronomical Journal*, I gave the principal steps, and the results, of a discussion of the positions of forty-eight circumpolar stars, selected for employment as standards in the longitude-determinations of the United States Coast Survey. The proper-motions were determined according to the method of least squares, from a comparison of modern catalogue-places, with the positions as obtained by BRADLEY, LALANDE, PIAZZI, and GROOMBRIDGE; and by application of these proper-motions, the results of more recent observations were referred to the mean equinox of the adopted epoch, and the adopted values of the right-ascensions and declinations thus deduced from modern observations alone.

These computations were made several years previous to their publication, at a time when few observations made later than 1850 were available; yet their results have in general surpassed my anticipations. Still the longitude-observations made and reduced under my direction during the last few years have shown the existence of palpable discordances for two or three stars. In every case these discordances have been found owing to the employment of proper-motions deduced from the ancient observations; and careful examination seems to indicate an incompatibility in several instances between recent observations and earlier ones, to an extent much surpassing the limits of the mean errors of observation.

I have accordingly instituted a new investigation of the places of all those stars of the circumpolar list, for which a discordance amounting to 0'.1 in right-ascension at the present time seems probable; and, since some appearances pointed to the possibility of an irregular or variable proper-motion, have recurred to the original observations whenever they have been accessible, instead of using the mean positions given in the several catalogues.

For eighteen of the forty-eight stars, every accessible observation has been employed in the new determination, and I now

propose to incorporate in the discussion of all doubtful cases the observations made by the longitude-parties with our small portable transit-instruments, thus obtaining the advantage of late observations which, although not instituted with the delicate appliances of an observatory, have yet proved trustworthy to a degree transcending my highest expectations.

I do not apprehend any changes exceeding 1" of a great circle, in the adopted position of any star upon the list, with a single exception. But the high declination of some of the stars renders a much smaller quantity than this very manifest, and I trust that errors of 0'.1 will prove rare. If they exist, it will be due solely to lack of materials for more precise determination of the proper-motion.

Before long I hope to present the circumpolar list with such amendments as may result from this new investigation. At present, however, I desire merely to correct the right-ascension and proper-motion of one star, in the same volume of the *Astronomical Journal* in which the original values were given,—postponing the other results until the new discussion shall be complete.

For the star No. 14, or *1 Draconis* of HEVELIUS, the proper-motion in right-ascension deduced from the observations of LALANDE, PIAZZI, or GROOMBRIDGE seems inadmissible, and instead of $\mu = -0'.0786$, as given on pages 13 and 78, the most probable value deducible from observations since the year 1815 is $\mu = +0'.0031$. This value will be somewhat changed by the employment of the Coast Survey observations, but the amount of the proper-motion in right-ascension is certainly small. The corresponding determination of the right-ascension for 1855.0 is

$$\alpha = 9^h 16^m 2^s.17 \pm 0'.02.$$

I propose subjecting our standard catalogue of 132 "time stars" to similar scrutiny, before it shall be published.

B. A. GOULD.

CAMBRIDGE, January, 1861.

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